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INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Established by Convention between Canada, Japan and the United States for the Conservation of the Fisheries Resources of the North Pacific Ocean

ANNUAL REPORT

FOR THE YEAR

1958

VANCOUVER, CANADA

1959

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

MEMBERS - 1958

CANADA

George R. Clark
John M. Buchanan
James C. Cameron
Roger T. Hager

UNITED STATES

Milton E. Brooding
Edward W. Allen
John H. Clawson
Ross L. Leffler (to Oct. 9, 1958)
Arnie J. Suomela (from Oct. 9, 1958)

JAPAN

Iwao Fujita
Koh Chiba (to Dec. 16, 1957)
Haruki Mori (from Dec. 16, 1957)
Kenjiro Nishimura
Kyuhei Suzuki

SECRETARIAT

Roy I. Jackson, Executive Director
Hiroshi Kasahara, Assistant Director

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

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ANNUAL REPORT

FOR THE YEAR

1958

OFFICES:

University of British Columbia
6640 N.W. MARINE DRIVE
Vancouver 8, B. C., Canada

LETTER OF TRANSMITTAL

The Chairman of the International North Pacific Fisheries Commission presents his compliments to the Contracting Parties and their Commissioners and has the honor to transmit herewith an Annual Report describing the activities of the Commission during the year terminating with the end of the Fifth Annual Meeting on November 10th, 1958.

The Report is presented in compliance with Article III(1)(f) of the International Convention for the High Seas Fisheries of the North Pacific Ocean and Rule 14(f) of the Rules of Procedure.

IWAO FUJITA,
Chairman.

FOREWORD

The International Convention for the High Seas Fisheries of the North Pacific Ocean came into effect when the signatory countries exchanged ratifications on June 12, 1953. The Commission, established under the Convention, held its organizational meeting in February, 1954, and its first annual meeting in October, 1954. The program of research, designed to determine the distribution, continental origin and extent of intermingling of salmon on the high seas, began operating in 1955 and has been continued on an intensive basis since that time.

This, the fifth Annual Report of the Commission, covers the year terminating with the adjournment of the annual meeting on November 10, 1958. As usual, the report is divided into three major parts. First, a report of the annual meeting, reviewing the Commission's progress in carrying out the terms of the Convention. Second, a brief account of the activities of the Commission's Secretariat during the year. Third, summary reports of the research being carried out, under the Commission's program and co-ordination, by fisheries research organizations in each of the three member countries. The views in the summaries are those of the authors and not necessarily those of the Commission.

Progress in research on the salmon questions raised by the Protocol has been outstanding. Knowledge of the distribution and intermingling of the several salmon species from the two continents is increasing steadily, although quantitative data on intermingling is deficient. The great extent of the area of intermingling and the many complexities of intermingling by species and by time make the problem of confirming or changing the provisional line, so that it more equitably divides the stocks of salmon from the two continents, a difficult one.

For the first five years following coming into force of the Convention, abstention from fishing by certain Contracting Parties on the salmon, halibut and herring stocks of the eastern North Pacific was operative without necessity of an annual determination as to continued qualification of the stocks originally specified. At the 1958 Annual Meeting, the Commission, for the first time, undertook a review of the qualification of stocks in question for continued abstention. No recommendation for a change in the stocks under abstention was made.

Studies of the stock of king crab of the eastern Bering Sea were continued by scientists of Japan and the United States, acting in accordance with a request made in 1954 by the United States under the provisions of Article III(1)(c)(i) of the Convention. Research has not yet progressed sufficiently to indicate whether or not joint conservation measures are required.

ROY I. JACKSON,
Executive Director.

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I. REPORT OF THE FIFTH ANNUAL MEETING 1958

of the

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Tokyo, Japan, November 4 to 10, 1958

1. TIME AND PLACE OF MEETING

The Fifth Annual Meeting of the International North Pacific Fisheries Commission was held at the Akasaka Prince Hotel in Tokyo, Japan, from November 4th to 10th, 1958. The Chairman of the meeting was Mr. Iwao Fujita of Japan.

The plenary sessions were preceded by and interspersed with meetings of the several standing and ad hoc committees which the Commission has established to assist in carrying out its work. Sessions of the Standing Committee on Biology and Research began on October 20th, under the chairmanship of Mr. James C. Cameron of Canada. The Ad Hoc Committee on Abstention began its work on October 28th, under the chairmanship of Mr. George R. Clark of Canada. The Ad Hoc Committee on the Protocol began its meetings on November 5th, also under the chairmanship of Mr. Clark. The Standing Committee on Finance and Administration met first on November 1st, with Mr. Arnie J. Suomela of the United States as Chairman. Meetings of the committees continued during available intervals between plenary sessions.

Japan, as host government, generously provided the meeting place and certain other facilities for the sessions.

2. PARTICIPANTS

Each of the member nations, Canada, Japan and the United States, was represented by a full complement of four commissioners at the Annual Meeting. The three plenary sessions and one *in camera* session were held under the chairmanship of Mr. Iwao Fujita. The twelve commissioners were accompanied by advisors, experts and, in some cases, members of their special advisory committees. At the invitation of the Commission, official observers were present from the Food and Agriculture Organization of the United Nations, the International Pacific Halibut Commission and the Union of Soviet Socialist Republics.

The total number of accredited participants in the Annual Meeting was 109; including 14 representatives from Canada, 54 from Japan, 23 representing the United States, 5 persons representing the observers and 13 permanent and temporary members of the Secretariat.

A list of the officers and members of the Commission and its various committees and the names of all accredited participants in the Fifth Annual Meeting are given in Appendix I of this report.

3. THE AGENDA

The Commission adopted, without change, the provisional agenda which had previously been circulated to all commissioners sixty days in advance of the meeting, as required by the Rules of Procedure. The agenda, as adopted, constitutes Appendix II of this report.

4. OPENING SESSION

The first plenary session, which, by Commission decision, is open to the public, was held in the Prince Hall of the Akasaka Prince Hotel in Tokyo on November 4th. The Chairman opened the meeting and introduced The Honorable Kunio Miura, Minister of Agriculture and Forestry for Japan. In his address of welcome, Mr. Miura extended Japan's cordial greetings to the representatives of Canada and the United States and to the official observers at the meeting. Attention was called to Japan's dependence on fisheries products and her genuine interest in the maintenance and development of the living resources of the sea. In closing, the Minister expressed the belief that mutual understanding and respect would bring the conference to a successful conclusion.

An address to the opening session was given by Mr. George R. Clark, leader of the Canadian delegation. Mr. Clark stressed the Commission's accomplishments in research and noted that the primary objective of the Convention is to promote conservation measures for the purpose of securing the maximum sustained productivity of fisheries of joint interest. It was Canada's view that perpetuation of the North Pacific salmon resource required that there must be restrictions on fishing activities by nationals of the three countries and some waiver of the right of free fishing. On behalf of the Canadian section, pleasure was expressed at the opportunity of again visiting Japan and renewing associations with colleagues from Japan and the United States.

Mr. Milton E. Brooding, Chairman of the United States Section, addressed the opening session on behalf of his delegation. Mr. Brooding voiced the pleasure of his group at having the opportunity to meet again with fellow commissioners

from Japan and Canada and to enjoy again the hospitality of Japan. Mr. Brooding spoke of the substantial progress made by the Commission in its first five years and summarized the obligations laid on the Commission by the Convention. He stressed the need for careful consideration of the conservation requirements of salmon stocks in the area of intermingling on the high seas and the hazard to preservation of some sockeye salmon runs of North American origin if provision was not made for conservation action.

Mr. Kyuhei Suzuki, speaking for the Japanese National Section, welcomed the delegates, observers and distinguished guests. Mr. Suzuki spoke with satisfaction of the progress made by the Commission, in its scientific studies, toward the goal of maximum sustained yield of fisheries resources of the North Pacific Ocean. He expressed the view that conservation measures for fisheries resources should be based on scientific findings and should be equitably applied to all those concerned.

The Chairman of the Commission, Mr. Iwao Fujita of Japan, extended a cordial welcome to the delegates and observers and to the many distinguished guests at the opening session. The Chairman referred to several major problems facing the Commission at this Annual Meeting. First, the question of whether the salmon, halibut and herring stocks of the North American coast continued to meet the scientific qualifications for abstention. Second, progress in studies to determine whether the provisional line forming the eastward boundary for Japanese salmon fishing should be confirmed in its present location, or relocated. It was the Chairman's view that these and other complicated problems with which the Commission is confronted could be brought to satisfactory solutions through a continuation of mutual understanding and friendship.

5. PROCEDURES FOR THE MEETING

The Commission again reviewed its policy with respect to attendance at plenary sessions, in the light of a view expressed by the United States that all plenary sessions, or at least the closing plenary session, should be open to the public, as well as the initial plenary session, which is now open. However, no change was made in the existing policy regarding attendance at meetings.

Commissioners Hager of Canada, Nishimura of Japan, and Suomela of the United States were designated by their national sections to deal with the press, with the assistance of the Secretariat. Representatives of the press were allowed to attend only the initial public plenary session.

The handling of minutes, reports and other matters of procedure followed precedents established in past years.

6. CONSIDERATION OF ADMINISTRATIVE MATTERS

a. Report of the Chairman

The address of the Chairman, Mr. Iwao Fujita of Japan, as given at the opening session (INPFC Doc. 247) was adopted by the Commission as the Chairman's report. In addition, the Chairman called attention to the interim meeting of the Ad Hoc Committee on Abstention, which had been held in Honolulu commencing on August 7th, 1958, and noted the exchange of biologists between the United States and Japanese Sections during 1958.

b. Report of the Secretary

The Secretary of the Commission, Mr. George R. Clark of Canada, reported that the functions of his office were covered by various documents being submitted to the Commission by the Secretariat and, therefore, no separate report would be made. Membership in the Commission during 1958 may be determined from the list given in the inside front cover of this Annual Report.

c. Report of the Executive Director

The Executive Director submitted the following reports to the Commission from the Secretariat:

i. Administrative Report for 1958 (INPFC Doc. 197)

ii. Report of the Commission's Auditors (INPFC Doc. 194)

iii. Budget Estimate and Forecast (INPFC Doc. 191)

iv. Statistical Yearbook, 1957 (INPFC Doc. 199)

v. Comments on the Form and Nature of the Reports Submitted Under Articles III(1)(c)(iii) and X(2) of the North Pacific Convention (INPFC Doc. 203)

vi. Report on the Use of Working Capital Funds in Other International Fisheries Organizations (INPFC Doc. 204)

These reports, dealing with a variety of administrative, procedural and statistical matters, were referred to the appropriate committees for information, review and report. Disposition of the reports is recorded in the sections of this report dealing with the work of the various committees.

d. Report of the Standing Committee on Finance and Administration

Matters of finance and administration on the Agenda for the plenary sessions were referred to the Committee on Finance and Administration for consideration. The Committee, under the chairmanship of Mr. Arnie J. Suomela, and with members as listed in Appendix I of this report, made a number of recommendations to the Commission, which subsequently adopted them. The recommendations are summarized below:

i. The Committee approved the accounts and report of the auditors, Peat, Marwick, Mitchell & Company, for the fiscal year ending June 30, 1958 and recommended their approval by the Commission. Expenses for operating the Commission's Secretariat totalled $39,325.96, Canadian funds, for the period. The auditors' report appears in Part II of this Annual Report.

ii. The Committee recommended that the Commission adopt the following budget for the operation of its headquarters for the fiscal year beginning July 1, 1959:

1. Personal Services	$29,299.00
2. Travel	6,500.00
3. Transportation of Things	300.00
4. Communications	1,200.00
5. Other Contractual Services	6,690.00
6. Supplies	1,500.00
7. Equipment	1,000.00
8. Cost of Annual Meeting	1,250.00
TOTAL (Canadian Funds)	$47,739.00

Each Contracting Party contributes one-third of the funds required for the operation of the Secretariat.

iii. The Committee presented to the Commission a budget forecast totalling $48,690.00, Canadian funds, for the fiscal year beginning July 1, 1960. In agreeing to the forecast, Japanese members of the Committee asked that the record show their desire that the total amount of the present forecast should not be exceeded in the future. The budget forecast is intended for the guidance of the national sections and is not to be considered for adoption by the Commission until the 1959 Annual Meeting.

iv. The Committee recommended that the "Administrative Report for 1958" (INPFC Doc. 197), as prepared by the Executive Director, should be adopted by the Commission. The report forms Part II of this Annual Report.

v. The Committee recommended that the Commission accept an invitation to be represented by an observer at the 1959 annual meeting of the International Commission for the Northwest Atlantic Fisheries. Mr. Arnie J. Suomela of the United States was designated to represent the Commission at the ICNAF meeting.

vi. The Committee recommended that an invitation to send an observer from this Commission to the eighth session of the Indo-Pacific Fisheries Council, in Columbo, Ceylon, should be declined, with appreciation and regrets.

vii. The Committee recommended that the Commission receive the report entitled "Comments on the Form and Nature of the Reports Submitted Under Articles III(1)(c)(iii) and X (2) of the North Pacific Convention" (INP FC Doc. 203), by the Executive Director, and transmit copies to the governments of Canada and the United States for their guidance in preparing future reports. In relation to this subject, the Committee agreed to record and report to the Commission, for the attention of the governments concerned, the desire of Japan to have immediate or prompt information on major changes in the regulations in areas and for stocks under abstention and, secondly, to receive an explanation of the scientific basis for major changes and amendments in fisheries regulations for such stocks.

viii. The Committee recommended that the report entitled "Report on the Use of Working Capital Funds in Other International Fisheries Organizations" (INPFC Doc. 204), by the Executive Director, should be received by the Commission and filed for reference purposes.

ix. The Committee recommended to the Commission that copies of the bound "Proceedings of the Annual Meeting" should be sent to officially-invited observers at annual meetings, in addition to the copies sent to those designated, from among their nationals, by each national section.

x. The Committee recommended that the first plenary session of the Sixth Annual Meeting of the Commission should be held on November 2nd, 1959. The period beginning on October 19th, 1959, and extending to the end of the annual meeting, was recommended for designation as the period within which committee sessions might be arranged by consultations between their respective chairmen and the Secretariat. (Site of the 1959 Annual Meeting was subsequently determined as Seattle, Washington.)

xi. The Committee recorded its appreciation of the excellent meeting and transportation facilities provided for this annual meeting by the Government of Japan.

7. IMPLEMENTATION OF THE PROVISIONS OF THE PROTOCOL TO THE CONVENTION

a. The Requirement

The Protocol to the North Pacific Convention requires the Commission to investigate the waters of the Convention area to determine if there are areas in which salmon originating in the rivers of Canada and of the United States of America intermingle with salmon originating in the rivers of Asia. If such areas are found the Commission is to conduct suitable studies to determine a line or lines which best divide salmon of Asiatic origin and salmon of Canadian and United States of America origin and whether it can be shown beyond a reasonable doubt that this line or lines more equitably divide such salmon than the provisional lines specified in Sections 1(c) and 2 of the Annex to the Convention. In accordance with these determinations the Commission shall recommend that such provisional lines be confirmed or that they be changed in accordance with these results, giving due consideration to adjustments required to simplify administration.

b. Research Progress

The large scale investigations essential to the solution of the biological aspects of these questions have been carried out by research agencies of the three countries, acting under the program and coordination of the Commission and its Committee on Biology and Research, since 1954. A broad view of progress to date can best be given by a quotation from the "Report of the Committee on Biology and Research on the Progress of Research on the Problems Raised by the Protocol" (INPFC Doc. 249), which was submitted to the Commission by the Committee and adopted at the 1958 Annual Meeting.

> "Since the Commission adopted its "Program of research on the problems raised by the Protocol" at its first annual meeting in 1954, much progress has been made in all four proposed fields of study—(1) fishing to discover the distribution of salmon on the high seas and to obtain samples for study, (2) the use of various techniques to distinguish between stocks of different origins and to recognize them in samples collected on the high seas, (3) tagging to obtain direct evidence of the movements of salmon and (4) study of the oceanographic background for salmon distribution and movements. All three countries have carried out extensive investigations, as shown by the reports presented at this meeting, a list of which is appended. The combined program is perhaps the greatest co-operative research project ever carried out in the fisheries field. It has not only greatly increased knowledge of salmon distribution pertinent to the Protocol problem but also has produced much which will be of more general value.
>
> "This Committee reported to the Commission at its 1957 Annual Meeting that "Sockeye, pink and chum salmon of Asian and North American origin intermingle in a broad area in the North Pacific and the Bering Sea, apparently extending over at least 30 degrees of longitude between 170°E. and 160°W." The first question in the Protocol has thus been answered but the large area of intermingling makes it very difficult to obtain a description of the high-seas distribution of salmon of various origins. There is evidence that each stock may vary from year to year in distribution as well as in size. Existing data suggest that salmon may be more available to the fishing gear at some time or places than at others. Furthermore the program, despite its size, still leaves many gaps. For such reasons as these it is not yet possible to describe the high-seas distribution of all important races of salmon quantitatively or even in some cases qualitatively. Research should continue on at least its present scale.
>
> "It is nevertheless possible to draw some conclusions of great interest to the Commission from the work already done. To this end, the reports on the various research projects have been considered very carefully first by five sub-committees on statistics, sampling, tagging, serological studies and scale studies and then by three sub-committees on the distribution of sockeye (red), pink and chum salmon. A brief summary of agreed conclusions reached in these discussions is given below and somewhat greater detail on their scientific backgrounds may be found in the reports of the sub-committees themselves appended to this report.
>
> "In 1958 all three countries again co-operated in special fishing by research vessels to sample salmon on the high seas by surface gill-netting. Specific oceanographic surveys were carried out in the area of interest by Japan and Canada, and all three countries made oceanographic observations from the research fishing vessels. The United States continued its tagging of salmon, mainly in the Aleutian region but also in the Gulf of Alaska, Japan for the first time tagged long-line caught salmon with promising results, mainly

south of the Aleutians. The United States continued its extensive studies of morphometric characters of sockeye, pink and chum salmon. Scale studies were conducted by Japan on sockeye, pinks and chums, by the United States on sockeye and pinks and by Canada on chums. The United States continued parasitological studies on chum salmon and Canada on sockeye and pinks. Serological studies were also conducted by the United States and Japan. Results of morphometric and scale studies reported at this meeting of course used material collected in 1957 or earlier, although some work on 1958 material has already started. Thus it is seen that the research is being pressed energetically by all three countries.

"In the following statements emphasis is placed on aspects of the distribution of sockeye, pink and chum salmon pertinent to the Protocol problem — i.e. on the eastward and westward extent of the distribution of Asiatic and North American stocks respectively. Lack of samples of salmon from the Asiatic mainland has constituted a major hindrance to the attempt to obtain a complete picture.

"1. DISTRIBUTION OF SOCKEYE SALMON. Fishing by research vessels and the Japanese commercial fishery have shown sockeye to be widely distributed in an area north of about 40°N. latitude in the western Pacific and about 50°N. in the eastern. In both 1956 and 1957 the greatest concentrations were found in the south-eastern Bering Sea in June, and just south of the Aleutian Islands in the late summer.

"Tagging along the Aleutian Islands and in the southern Bering Sea in 1956, 1957 and 1958 did not lead to any recoveries east of Kodiak in spite of great efforts to discover tagged fish there. It appears, therefore, that the North American red salmon in the area of intermingling with Asian salmon originate mainly in Western Alaska. The latter area has, in recent years as in the past, had larger stocks of red salmon than Asia.

"Recoveries of red salmon tagged along the Aleutian Islands and in the southern Bering Sea from May to August in 1956 and 1957 indicate that salmon of Alaskan origin predominated as far west as 175°E. A similar tendency was observed in morphometric studies (using the generalized distance function) which showed that high-seas samples taken east of 175°E. in 1956 and 1957 were more like Bristol Bay than Okhotsk Sea samples, while the opposite was true of samples west of 170°E. The presence of Bristol Bay red salmon as far west as 171° E. was shown by parasitological studies, and serological studies found antigens characteristic of North American samples as far west as 175°E. It may thus be concluded that red salmon of Alaskan origin occurred in 1956 and 1957 as far west as 171°E. and that mature red salmon sampled in these years along the Aleutians and in the southern Bering Sea were predominantly of Alaskan origin as far west as 175°E.

"On the other hand sockeye salmon with Asian parasite characteristics were found as far east as 170°W. Scale studies have shown that sockeye of age groups 5_2 and 6_3 in samples collected in June 1956 and 1957 between 175°E. and 175°W. were mostly of American type in the Bering Sea and of Asian type south of the Aleutians. Japanese serological studies found salmon similar to those near the southern part of Kamchatka south of the Aleutians, while those north of the Aleutians were dissimilar. It is thus clear that sockeye salmon of Asian origin occur as far east as 170°W.

"Some evidence has been found of differences between the east-west distribution of Asian and North American salmon in 1956 and 1957. These differences suggest some year to year variation but do not contradict the conclusions stated above.

"The dynamic, rather than static, nature of the distribution of red salmon is emphasized. It is further elaborated in Item 5 of the report of the sub-committee on red salmon distribution.

"2. DISTRIBUTION OF PINK SALMON. With reference to the reports of the four technical sub-committees on tagging, scale analysis, sampling and statistics, and in view of the limitations that there exist marked intraseasonal and interseasonal fluctuations in the numbers and distribution in the high-seas and that our investigations have just started since 1955, the sub-committee on distribution of pink salmon agreed that some aspects had been revealed on distribution in the high seas of pink salmons of the Asian and North American origins but that any quantitative conclusion was still impossible.

"On the basis of information so far available, it is summarized as follows:

"(1) Coastal distribution: On the Asian side, pinks are distributed in the whole coastal waters from Hokkaido to the Arctic, while on the North American side large concentrations are found south of the Alaska Peninsula and relatively smaller runs in the Alaskan coastal waters of the Bering Sea.

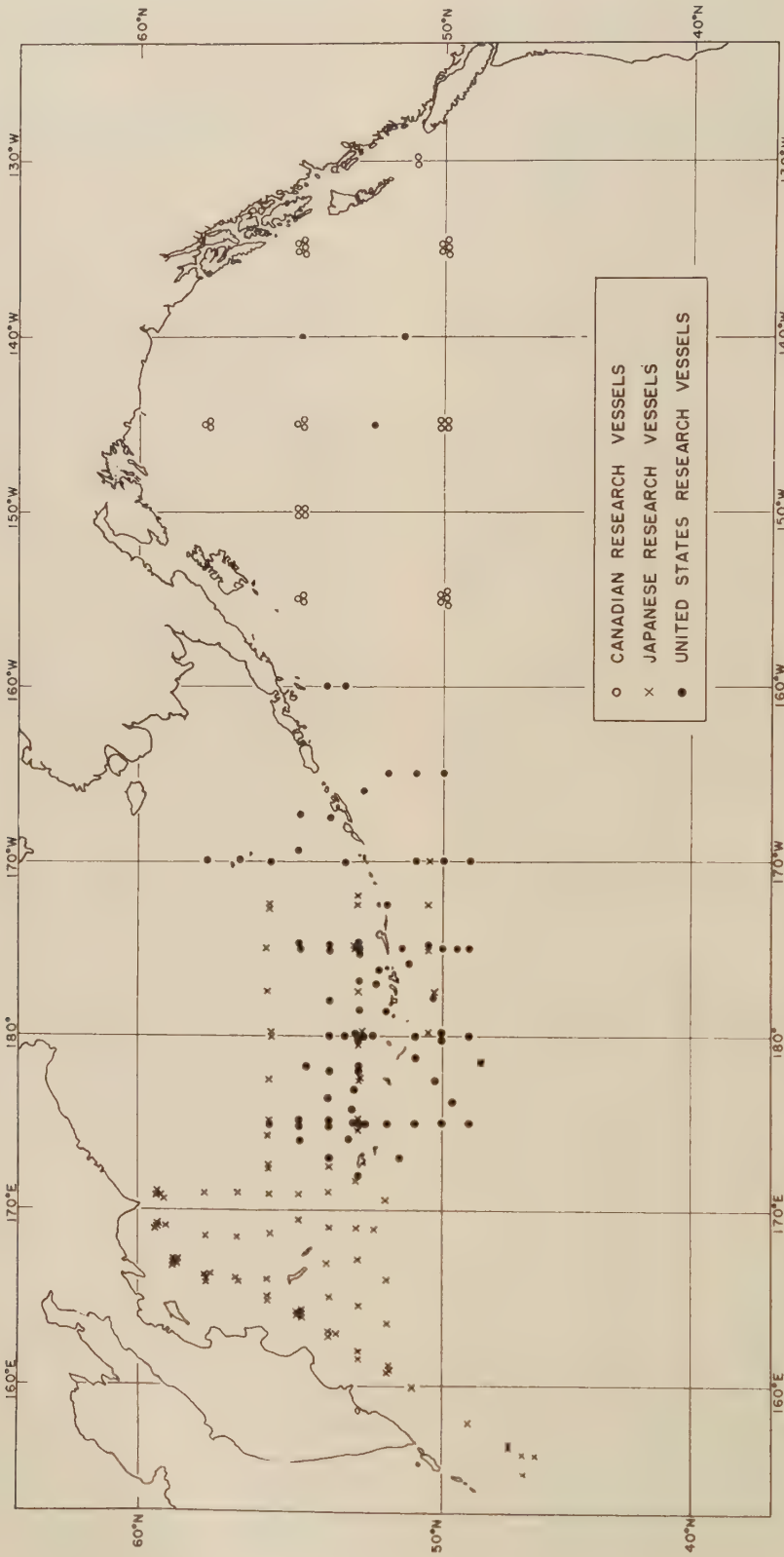


FIGURE 1. Fishing stations actually occupied by the research vessels of the three countries, 1958.

"(2) High seas distribution: The southern limit of the oceanic distribution through the fishing season is at about 40°N. latitude near the Asian and the North American coasts and around 45°N. to 50°N. in the mid-ocean. However, these limits change both within years and, at least in the western Pacific, between years.

"(3) Possible extent of pinks of both origins: From the tagging work, it was shown that the Asian pinks were distributed as far east as 163°W. in 1957 and that the North American pinks occurred as far west as 177°E. in 1958; it is not intended to infer that American and Asian salmon were not also widely distributed in 1957-1958 respectively.

"These observations are based upon the reports of the five technical sub-committees as well as that on distribution of pink salmon, to all of which careful consideration should be given as integral parts of this summary.

"3. DISTRIBUTION OF CHUM SALMON.

Stocks of chum salmon spawn in streams of North America from south of the Columbia River to Arctic Alaska, and out along the Aleutian Islands. Asian stocks spawn from Hokkaido northward to northern Kamchatka. After a brief freshwater existence these fish migrate to sea to participate in extensive oceanic migrations, the nature of which was little understood as recently as 1954. During these feeding migrations the fish achieve rapid growth, and return to their native streams to spawn at ages of 3 to 6 years, most commonly 4 or 5 years, providing a lengthy period of vulnerability to high-seas fishing.

"During the years 1955 through 1958, there has been intensive research on the oceanic migrations and distribution of chum salmon by Japan, Canada and the United States, as part of the general program of research sponsored by the International North Pacific Fisheries Commission. Scientists have studied samples of fish from the major high seas and inshore areas of occurrence.

"In reviewing the evidence as to offshore distribution of Asian and North American stocks of chum salmon, the Committee has referred to some 11 documents reporting results of the research programs mentioned above, as well as 5 of the sub-committee reports (sampling, scale analysis, tagging, statistics and chum salmon distribution) of the current Commission session. Research has included 4 approaches; (1) examination of scale structure, (2) tagging, (3) identification and enumeration of parasites, (4) comparison of morphological and meristic characters.

"After a thorough review of the validity and stage of development of each technique, the Committee placed primary reliance on scale analysis and tagging in discovering its conclusions, although the other two approaches were also considered. Since data from 1958 operations have not yet been fully analyzed, consideration was limited to data for the years 1955 through 1957. Evidence now available from scale analysis is based mainly on comparison of circulus counts, and shows the principal area of intermingling of North American and Asian fish centered about meridian 175°W. longitude, and exending at least 10° of longitude on either side, north and south of the Aleutian Islands. Recoveries of fish tagged on the high seas showed Asian fish as far east as 167°W. and North American fish as far west as 177°W. There were some technical questions to be resolved for the parasite and morphological approaches, but nevertheless the findings were not contrary to those for scales and tagging.

"Within the broad area of intermingling indicated above, it is not possible at the present stage of development of the research techniques to assess the exact proportion of North American and Asian stocks present at particular locations and at particular times of the fishing season. The Committee feels, however, that further refinement and testing of the methods will ultimately permit such assessment, in view of the promising progress already made, and that all techniques should be continued.

"The Committee agreed on the following conclusion. In 1956 and 1957 there existed an area of intermingling both north and south of the Aleutians at least between longitude 167° W. and 177°W. However, the exact range of intermingling and the precise proportion of North American and Asian fish in this area could not be determined.

"4. OCEANOGRAPHY. It is not possible to summarize the extensive oceanographic results in a brief statement. Suffice it to say that great progress has been made in describing the physical oceanography of the region occupied by salmon. It is characterized by relatively low salinity surface water which differentiates it from waters further south and which is apparently subject to much recirculation. Year-to-year differences in the distribution of properties and in water movements have been found which may well influence the distribution of salmon. Some instances of relation between the limits of distribution of salmon stocks and the boundaries of water masses appear to be emerging. The oceanographic studies

thus show promise of considerable value to an understanding of the distribution of salmon stocks and their changes. This, together with their more general value to the development of fisheries, makes it highly desirable that they be continued energetically."

c. Research Plans for 1959

Plans for research during 1959 were carefully developed by the Committee on Biology and Research during the 1958 Annual Meeting. The Committee summarized its 1959 research program as follows:

"1) In order to meet the problems raised by the Protocol, research should be continued on at least the same scale as in 1958 along all the principal lines now in progress.

"2) Offshore fishing by research vessels will continue at about the same level as last year, but with greater emphasis on depth distribution studies by Canada and on north to south distribution by the United States. The need for increased samples from the area south of the Aleutians between 170°E. and 155°W. was noted.

"3) Tagging by the United States will continue on about the same scale as last year. The Japanese tagging program, utilizing long-lines, will be expanded.

"4) Oceanographic work will proceed at about the same level as last year.

"5) Racial studies, including serology, morphology, scale studies and parasitology will continue as in the previous year with some changes in emphasis.

"6) The need for obtaining more representative "shore" samples from all important runs throughout the North Pacific area was stressed.

"7) The desirability of combining information on the commercial catches of shore-based fisheries, on the catches of the Japanese high seas fishery and on the catches of the high seas experimental fishing operations to give a unified picture of the distribution and abundance of salmon throughout the North Pacific area was recognized.

"8) It was recognized that the plans prepared by the sub-committee were tentative and must be subject to amplification and modification as analysis of past data proceeds.

"In reviewing the findings of the sub-committee on research plans, the Committee recognized the need for closer co-operation in the planning and conduct of research in the forthcoming year and strongly recommends that, if feasible, arrangements for the 1959 program be finalized as much as possible through personal contact of the scientists involved in the actual programs.

"It was agreed that more time and thought should be given to long range planning, and that special attention should be paid to this through submission by each section at the next meeting of the Biology and Research Committee of its long term plan for attaining the various research objectives of the Treaty. The plans should include, as an example, consideration of the information necessary to give quantitative meaning to research data. An outline stating the biological and statistical data which would be required to implement the plans should be included. It is recognized that such plans shall not be binding and should be only for the purpose of furthering joint annual planning.

"The Committee recommends that summaries of both general and specific research plans be circulated well in advance of the next annual meeting."

d. Application of Research Findings

At the fifth plenary session of the 1957 Annual Meeting, the Commission established an ad hoc committee to " . . . consider application of the results of research to adjustment of the provisional lines in accordance with the terms of the Protocol." In agreeing to establishment of the ad hoc committee, the Japanese National Section did so on two conditions, first, that details for establishment of the committee should be discussed at the next (1958) annual meeting and second, that there were as yet no results of research suitable for application in connection with the implementation of the Protocol.

At the second plenary session of the 1958 Annual Meeting the Commission adopted terms of reference for the committee referred to above. These terms of reference are as follows:

1. The Commission establishes an Ad Hoc Committee on the Protocol which shall consist of one member designated by each national section who may be accompanied by experts or advisors.
2. Attendance at all meetings of the Committee shall be limited to those designated by their respective national sections as members, experts or advisors with the understanding that the group shall be kept small. Records shall be kept and distributed on a confidential basis.
3. The national sections shall as soon as possible advise the Executive Director of the name of their Commissioner who will serve on the Ad Hoc Committee together with their experts and advisors.

4. The Committee shall study and consider the results of scientific investigations referred to it by the Commission for the purpose of recommending to the Commission, as expeditiously as practicable, what action, if any, may be desirable or necessary for the discharge of the responsibilities set forth in the Protocol.

5. The Committee shall be authorized to consider and report to the Commission on any problem which the Committee finds pertinent to the implementation of the provisions of the Protocol.

6. The Committee shall continue to function and conduct its studies and considerations until such time as otherwise determined by the Commission.

Having established the Ad Hoc Committee on the Protocol, the Commission referred to it the Report of the Committee on Biology and Research (INPFC Doc. 249) entitled, "Report of the Committee on Biology and Research on the Progress of Research on the Problems Raised by the Protocol". The Ad Hoc Committee on the Protocol, under the chairmanship of Mr. George R. Clark of Canada, and with members as given in the List of Participants, met during the course of the 1958 Annual Meeting for the purpose of carrying out its assigned functions. Attendance at meetings of the Committee was restricted to those persons designated as members or advisors by their respective national sections. The Committee's report to the Commission was dealt with and adopted on an *in camera* basis and its contents have not been given general distribution. However, certain portions of the First Report of the Ad Hoc Committee on the Protocol were read into the record of the third plenary session of the Commission, in accordance with an agreement made at an earlier *in camera* Commission session. The statement for the record, quoted below, was proposed by Canada and adopted in principle by members of the Ad Hoc Committee on the Protocol for Japan and the United States.

"1. The Annex and the Protocol form an integral part of the Convention. There seem to be no differences of opinion on this point.

"2. There is no doubt, as shown by the scientific research, that there is a wide area of intermingling of the stocks of salmon from both continents.

"3. There is room for doubt that the abstention provisions in the Convention were meant to be absolute.

"4. The interest of the three countries, in the long range, is in adequate conservation and sound management pratices.

"5. Failure by this Commission to take account of conservation will, in our opinion, jeopardize not only in our own countries, but as well in the eyes of the world, the very foundation of the Convention, which is expressed in the preamble to the Convention."

No other conclusions were reached by the Ad Hoc Committee on the Protocol or the Commission on other problems or matters involved in the Protocol.

8. IMPLEMENTATION OF THE PROVISIONS OF ARTICLE III(1)(a) OF THE CONVENTION (ABSTENTION)

Under the provisions of the North Pacific Convention, some of the Contracting Parties have agreed to abstain from fishing for certain stocks of fish, providing that the Contracting Parties which continue to fish these stocks fulfill certain obligations. Because the subject is a highly technical one, it will be best to quote verbatim the pertinent parts of the Convention, rather than attempt to paraphrase them.

Article V, Section 2, which reads as follows, contains the agreement of the Contracting Parties with respect to abstention:

"2. The Contracting Parties recognize that any stock of fish originally specified in the Annex to this Convention fulfills the conditions prescribed in Article IV and accordingly agree that the appropriate Party or Parties shall abstain from fishing such stock and the Party or Parties participating in the fishing of such stock shall continue to carry out necessary conservation measures."

The Annex to the Convention, defining the stocks and waters under abstention, reads as follows:

"1. With regard to the stocks of fish in the respective waters named below, Japan agrees to abstain from fishing, and Canada and the United States of America agree to continue to carry out necessary conservation measures, in accordance with the provisions of Article V, Section 2 of this Convention:

"(a) Halibut (*Hippoglossus stenolepis*)

"The Convention area off the coasts of Canada and the United States of America in which commercial fishing for halibut is being or can be prosecuted. Halibut referred to herein shall be those originating along the coast of North America.

"(b) Herring (*Clupea pallasii*)

"The Convention area off the coasts of Canada and the United States of America, exclusive of the Bering Sea and of the waters of the North Pacific Ocean west of the meridian passing through the extremity of the Alaskan Peninsula, in which commercial fishing for herring of North American origin is being or can be prosecuted.

"(c) Salmon (*Oncorhynchus gorbuscha, Oncorhynchus keta, Oncorhynchus kisutch, Oncorhynchus nerka, Oncorhynchus tschawytscha*)

"The Convention area off the coasts of Canada and the United States of America, exclusive of the Bering Sea and of the waters of the North Pacific Ocean west of a provisional line following the meridian passing through the western extremity of Atka Island; in which commercial fishing for salmon originating in the rivers of Canada and the United States of America is being or can be prosecuted.

"2. With regard to the stocks of fish in the waters named below, Canada and Japan agree to abstain from fishing, and the United States of America agrees to continue to carry out necessary conservation measures, in accordance with the provisions of Article V, Section 2 of this Convention:

"Salmon (*Oncorhynchus gorbuscha, Oncorhynchus keta, Oncorhynchus kisutch, Oncorhynchus nerka and Oncorhynchus tschawytscha*)

"The Convention area of the Bering Sea east of the line starting from Cape Prince of Wales on the west coast of Alaska, running westward to 168°58′22.59″ West Longitude; thence due south to a point 65°15′00″ North Latitude; thence along the great circle course which passes through 51° North Latitude and 167° East Longitude, to its intersection with meridian 175° West Longitude; thence south along a provisional line which follows this meridian to the territorial waters limit of Atka Island; in which commercial fishing for salmon originating in the rivers of the United States of America is being or can be prosecuted."

Article III, Section 1(a) of the Convention requires the Commission to perform the following functions:

"(a) In regard to any stock of fish specified in the Annex, study for the purpose of determining annually whether such stock continues to qualify for abstention under the provisions of Article IV. If the Commission determines that such stock no longer meets the conditions of Article IV, the Commission shall recommend that it be removed from the Annex. Provided, however, that with respect to the stocks of fish originally specified in the Annex, no determination or recommendations as to whether such stock continues to qualify for abstention shall be made for five years after the entry into force of this Convention."

The provisions of Article IV, referred to in Article III(1)(a), are often referred to as the "qualifications for abstention". They are found principally in Section 1 of Article IV, quoted below:

"1. In making its recommendations the Commission shall be guided by the spirit and intent of this Convention and by the considerations below mentioned.

"(a) Any conservation measures for any stock of fish decided upon under the provisions of this Convention shall be recommended for equal application to all Parties engaged in substantial exploitation of such stock.

"(b) With regard to any stock of fish which the Commission determines reasonably satisfies all the following conditions, a recommendation shall be made as provided for in Article III, Section 1(b).

"(i) Evidence based upon scientific research indicates that more intensive exploitation of the stock will not provide a substantial increase in yield which can be sustained year after year,

"(ii) The exploitation of the stock is limited or otherwise regulated through legal measures by each Party which is substantially engaged in its exploitation, for the purpose of maintaining or increasing its maximum sustained productivity; such limitations and regulations being in accordance with conservation programs based upon scientific research, and

"(iii) The stock is the subject of extensive scientific study designed to discover whether the stock is being fully utilized and the conditions necessary for maintaining its maximum sustained productivity. . . . . ."

Attention is drawn to the fact that, for stocks originally specified in the Annex, no determination or recommendation as to whether such stocks continue to qualify for abstention shall be made for five years after the entry into force of the Convention. This five-year period expired on June 12, 1958. For that reason, the 1958 Annual Meeting afforded the Commission its first opportunity to carry out the provisions of Article III(1)(a) of the Convention.

In preparation for making the determinations required under Article III(1)(a), the Commission had called, at its 1955 Annual Meeting, for reports from the appropriate Contracting Parties as to whether the stocks listed in the Annex continue to qualify under the provisions of Article IV. These basic reports, received at the 1956 Annual Meeting, and a large volume of supplementary information subsequently requested and received by the Commission, have formed the basis of the Commission's deliberations on these questions. In order to deal expeditiously with these highly technical problems, the Commission established, in 1956, a committee, called the "Ad Hoc Committee for Study of Reports Submitted Under Article III(1)(a)", to study the "abstention" reports and obtain, to the extent possible, on-the-spot clarification of obscure points, if any; and to determine whether or not further information should be requested. Prior to the 1958 Annual Meeting, this committee was renamed the "Ad Hoc Committee on Abstention". Earlier, at the 1957 Annual Meeting, its terms of reference had been amended to provide that it might make recommendations to the Commission on the determinations required under Article III(1)(a).

Membership of the Committee is given in the List of Participants (Appendix I). The Committee met in Honolulu from August 7th to 11th, 1958 and met again in Tokyo in the period immediately prior to and during the 1958 Annual Meeting.

At the third plenary session of the 1958 Annual Meeting, the Chairman of the Commission reported as follows, with respect to the implementation of Article III(1)(a) of the Convention:

> "In accordance with the provisions of Article III(1)(a) the Committee (Ad Hoc Committee on Abstention) studied for the purpose of determining annually whether the stocks of fish specified in the Annex continue to qualify for abstention. Studies were made of the reports submitted by Canada and the United States; consideration was given to the comments on these reports made by the Japanese scientists and the further comments made by the Canadian and United States Sections.
>
> "No agreement, however, was reached at this time, with respect to the conclusions on he studies, as to whether such stocks continue to qualify for abstention.
>
> "The Committee therefore makes no recommendation at this time that the Commission make a determination that the stocks specified in the Annex no longer meet the conditions of Article IV.

(In effect — abstention on the stocks listed in the Annex will continue, until a determination, etc., that the stocks no longer qualify, is made.)

> "The Committee recommends that it continue its work.
>
> "The Committee further recommends that a scientific sub-committee be established immediately to study and clarify the technical and scientific aspects of the reports and reviews. Such sub-committee shall be composed of one scientist selected by each national section, who may be accompanied by experts and advisors."

Members of the scientific sub-committee were subsequently designated as Dr. A. W. H. Needler for Canada, Dr. Motosaku Fujinaga for Japan, and Mr. Donald L. McKernan for the United States. The Executive Director was given the assignment of making organizational arrangements which would enable the sub-committee to carry on its work.

9. IMPLEMENTATION OF ARTICLES III (1)(c)(i) AND III(1)(c)(ii) OF THE CONVENTION, WITH RESPECT TO KING CRAB

Articles III(1)(c)(i) and III(1)(c)(ii) of the Convention provide that the Commission shall, in regard to any stock of fish in the Convention area:

> "(i) Study, on request of any Contracting Party concerned, any stock of fish which is under substantial exploitation by two or more of the Contracting Parties, and which is not covered by a conservation agreement between such Parties existing at the time of the conclusion of this Convention, for the purpose of determining need for joint conservation measures;
>
> "(ii) Decide and recommend necessary joint conservation measures including any relaxation thereof to be taken as a result of such study. Provided, however, that only the national sections of the Contracting Parties engaged in substantial exploitation of such stock of fish may participate in such decision and recommendation. The decisions and recommendations shall be reported regularly to all the Contracting Parties, but shall apply only to the Contracting Parties the national sections of which participated in the decisions and recommendations."

Under the provisions of this Article, the Commission, at the request of the United States, undertook in 1954 a study of the king crab stocks of the eastern Bering Sea for the purpose of determining if joint conservation measures, by Japan and the United States, are needed. The Committee on Biology and Research reviewed the results of research on the king crab (*Paralithodes camtschatica*) to date and . . . .

> " . . . agreed that excellent progress is being made toward the solution of the problem assigned by the Commission. The studies have been carefully co-ordinated, and the work of the two sections is mutually supporting with little duplication of effort.
>
> "Japan's analysis of catch data is proceeding well, but has not yet been completed. The United States believes that it will be possible to produce preliminary estimates of growth rate and mortality for male crabs of commercial size within the next year.
>
> "However, the king crab studies of the Commission have not reached the stage where specific recommendations for joint conservation measures with respect to the existing fishery can be made." (INPFC Doc. 265)

Research plans for 1959 by Japan and the United States envisage continuation of king crab research programs along lines established in the past several years.

As a result of the view expressed by the Committee on Biology and Research, to the effect that king crab studies have not reached the stage where specific recommendations for joint conservation measures with respect to the existing fishery can be made, the Commission agreed, at its third plenary session, that it would not be necessary to take any action on implementation of Article III(1)(c)(ii) of the Convention at this time; i.e., no recommendation for joint conservation measures would be made at present.

10. IMPLEMENTATION OF THE GENERAL PROVISIONS OF THE CONVENTION

At the final plenary session of the 1958 Annual Meeting, the Chairman of the Commission read into the record the following resolution, which had been unanimously adopted by the Ad Hoc Committee on the Protocol and by the Commission:

> "In view of the results of scientific investigations to date as contained in the reports of the Committee on Biology and Research and in accordance with the objective of conservation of fishery resources of the North Pacific Ocean, as expressed in the International Convention for the High Seas Fisheries of the North Pacific Ocean, the Ad Hoc Committee on the Protocol recommends that the International North Pacific Fisheries Commission respectfully recommend to the Governments of the Contracting Parties that full consideration be given to the conservation needs of these fisheries resources in the area of common concern when preparing fishing regulations for future operations."

In addition to the resolution on conservation quoted above, the Commission heard general views on the progress of its conservation work expressed by spokesmen for the three national sections.

The spokesman for the United States National Section, Mr. Milton E. Brooding, felt that real progress had been made in the scientific investigations which form so important a part of the Commission's work. It was gratifying to find wide areas of agreement among the scientists of the three countries. However, the United States Section felt keenly disappointed that the Commission had not come to some understanding regarding the conservation problem existing in the areas of heavy intermingling of Asian and North American salmon stocks. The utmost concern was expressed for the preservation of the Bristol Bay sockeye salmon fishery. Mr. Brooding stated that the United States fishery in Bristol Bay had been drastically regulated in order to ensure an adequate escapement of spawners. Reference was made to the report of the Committee on Biology and Research showing that mature sockeye salmon sampled along the Aleutians and in the southern Bering Sea in 1956 and 1957 were predominantly of Alaskan origin as far west as 175°E. longitude. It was further stated that the Japanese high seas fishery had harvested millions of salmon in areas where Bristol Bay sockeye predominate.

The United States spokesman expressed a view that the 1959 Bristol Bay sockeye salmon run would be about the same size as the poor run of 1958 and that, therefore, even if extensive conservation measures were applied to the Japanese high-seas fishery, it would still be necessary to impose regulations on the United States inshore fishery far more drastic even than in 1958. If the Japanese high-seas fishery was not subject to conservation restrictions, such as cessation of fishing in the areas of intermingling or the equivalent, the United States faced the prospect of closing down entirely the fishery in Bristol Bay.

The spokesman for the Canadian National Section, Mr. George R. Clark, expressed the belief that the work of the Commission at its 1958 Annual Meeting had made it obvious that the Commission clearly recognizes its specific and general responsibilities. It was felt that the Commission had accomplished a great deal toward successfully discharging its scientific and practical functions and that progress would be continued in the future.

The spokesman for the Japanese National Section, Mr. Kenjiro Nishimura, called attention to the obligation placed on the Commission by the Convention — to ensure the maximum sustained productivity of the fisheries resources of the North Pacific Ocean and to encourage the conservation of such resources and promote the scientific studies necessary to ascertain the required conservation measures. Two steps were being taken by the Commission toward this objective; first, to review the abstention conditions for stocks specified in the Annex and second, to solve the question raised by the Protocol, i.e., confirmation or relocation of dividing lines for salmon fishing. Gratification was expressed with progress being made by the Ad Hoc Committee on Abstention, although it was noted that agreement had not been reached on the question of whether the stocks of fish concerned no longer qualified for abstention.

Work of the scientists on the Protocol question had contributed greatly to clarification of knowledge of the salmon resources of the North Pacific. However, research so far conducted still did not offer a sufficient basis for the solution of the problem raised by the Protocol. The Committee on Biology and Research had reported little progress to date on quantitative aspects of salmon distribution and information was not complete on qualitative aspects of their distribution. The spokesman for Japan thought the Commission should urge the scientists of the three countries to continue further scientific studies of salmon distribution questions, including the question as to whether the Japanese offshore salmon fishery has any effect on the red salmon resources of Bristol Bay.

With respect to the conservation resolution adopted by the Commission as cited earlier in this section of this report, the spokesman for the Japanese Section stated that Japan, as one of the major fishing countries of the world, had always given careful consideration to the questions of conservation and offered assurance that Japan would continue to give full consideration to this important question.

11. OTHER MATTERS

a. Statistical Yearbook

The Committee on Biology and Research reviewed and commended the Statistical Yearbook for 1957, as prepared by the Secretariat. The yearbook contains statistics on fisheries of joint interest to the three Contracting Parties. The Committee also recognized the need for obtaining more detailed statistics of the Japanese high-seas salmon fishery operations and agreed that every effort should be made to obtain such data.

b. Reports Under Article III(1)(c)(iii)

Article III(1)(c)(iii) of the Convention requires the appropriate Contracting Party or Parties to report regularly the conservation measures adopted from time to time with regard to the stocks of fish specified in the Annex to the Convention. The Committee on Biology and Research recommended to the Commission, which agreed, that the Secretariat prepare annual comments on the form and nature of these reports and make its views available to each national section and that the Committee no longer be required to consider the form and nature of reports submitted under Article III(1)(c)(iii).

c. Publication Policy

The Commission approved a recommendation by the Committee on Biology and Research that an addition be made to the policy for publication of scientific reports by the Commission, as follows:

> "**That** authorship of all papers presented for publication shall be shown and that publication by the Commission shall not indicate endorsement or approval of the contents thereof, unless so stated."

The basic policy for publication of scientific reports by the Commission was defined at the 1957 Annual Meeting.

12. NEW OFFICERS

At its final plenary session, the Commission elected the following officers, all of whose terms began with the close of the 1958 Annual Meeting and will terminate with the close of the 1959 Annual Meeting:

Chairman of the Commission—Mr. Edward W. Allen of the United States.

Vice-Chairman—Mr. George R. Clark of Canada.

Secretary—Mr. Iwao Fujita of Japan.

Chairman of the Committee on Biology and Research—deferred until a nomination is made by Japan at a later date.

Chairman of the Committee on Finance and Administration—Mr. Roger T. Hager of Canada.

It had previously been decided by the committees concerned that Mr. George R. Clark of Canada would continue as Chairman of the Ad Hoc Committee on Abstention and of the Ad Hoc Committee on the Protocol until such time as these committees convene their next meetings.

13. FUTURE MEETINGS

The Sixth Annual Meeting of the Commission will commence in Seattle, Washington, on November 2, 1959. Meetings of the various committees are to be arranged by correspondence between their chairmen and the Secretariat, with the understanding that the period beginning on October 19, 1959 and extending until the beginning of the plenary sessions on November 2 will be available for the scheduling of committee meetings.

APPENDIX I
LIST OF PARTICIPANTS
OFFICERS OF THE MEETING

CHAIRMAN
Iwao Fujita, Japan

VICE-CHAIRMAN
Edward W. Allen, United States

SECRETARY
George R. Clark, Canada

CANADA

Commissioners

George R. Clark,
Ottawa, Canada

John M. Buchanan,
Vancouver, B. C.

James C. Cameron,
Madeira Park, B. C.

Roger T. Hager,
Vancouver, B. C.

Advisors and Experts

A. W. H. Needler
W. M. Sprules
F. Neave
M. P. Shepard
K. S. Ketchen
L. Margolis
A. J. Dodimead
F. H. C. Taylor
D. B. DeLury
R. Duder

JAPAN

Commissioners

Iwao Fujita,
Tokyo, Japan

Haruki Mori,
Tokyo, Japan

Kenjiro Nishimura,
Tokyo, Japan

Kyuhei Suzuki,
Tokyo, Japan

Advisors

Hideo Okuhara
Shinkichi Katayanagi
Kenkichi Nakabe
Koichiro Kobayashi

Experts (Foreign Ministry)

Keisuke Arita
Kei Miyakawa
Hiroshi Ohki
Ryo Kawade
Chusei Yamada
Toshio Isogai

Experts (Fisheries Agency)

Yoshimasa Sakamura
Motosaku Fujinaga
Hisao Nakazato
Tohru Sone
Motonobu Inagaki
Yoshiji Shigeta
Hirotsugu Suzuki
Shiro Yoshizaki
Shigeo Miyamoto
Taizo Kitta
Ryuichi Tanabe
Kiichiro Yamahira
Tomonari Matsushita
Seiwa Kawasaki
Makoto Miyake

Experts (Universities)

Hiroaki Aikawa
Yasuo Suyehiro
Tamao Fukui
Tomokichi Yoshihara
Ryuhei Sato
Tatsuro Kubo

Experts (Laboratories attached to the Fisheries Agency)

Sakae Sato
Mitsuo Konda
Teruo Ishida
Tamotsu Yonemori
Kiyomitsu Kitano
Yoshio Fukuda
Fukuzo Nagasaki
Shoichi Tanaka
Seizo Sano
Tetsuo Kobayashi

Experts (Hokkaido Prefectural Government)

Yoshimi Hirano
Nobuhiko Hanamura

Experts (Industry)

Takeo Ito
Hiroshi Tominaga
Tojiro Shinada
Kisaburo Taguchi
Hideyoshi Yoshihara
Toranosuke Yoshimitsu
Hiroshi Hirose

UNITED STATES

Commissioners

Milton E. Brooding,
San Francisco, California

Edward W. Allen,
Seattle, Washington

John H. Clawson,
Anchorage, Alaska

Arnie J. Suomela,
Washington, D.C.

Advisors

C. E. Atkinson
F. C. Cleaver
R. A. Fredin
W. C. Herrington
D. L. McKernan
L. Nakatsu
W. F. Royce
R. P. Silliman
W. M. Terry
W. F. Thompson
W. G. Van Campen

Advisory Committee

C. L. Anderson
A. M. Day
DeWitt Gilbert
R. C. Kallenberg
H. E. Lokken
M. Moore
J. W. Smith
L. Wakefield

OBSERVERS

Food and Agriculture Organization of the United Nations

Colin Beever,
Rome, Italy

International Pacific Halibut Commission

William A. Bates,
Ketchikan, Alaska

Union of Soviet Socialist Republics

R. S. Semko,
Petropavlosk, Kamchatka

A. A. Volkov,
Moscow, U.S.S.R.

B. Proskuriakov (Interpreter)

SECRETARIAT

Permanent

Roy I. Jackson,
Executive Director

Hiroshi Kasahara,
Assistant Director

Temporary

R. Katsurayama
R. Tatsuoka
F. Villas
N. Nasu
A. Oshima
N. Nakajima
S. Taguchi
C. Suzuki
K. Mizuta
J. Kuwana
Y. Takahashi

MEMBERSHIP OF COMMITTEES

1. STANDING COMMITTEE ON FINANCE AND ADMINISTRATION

CANADA

Commissioner-member.....Roger T. Hager

Advisor-member.....George R. Clark

JAPAN

Commissioner-member.....Haruki Mori

Advisor-member.....Hisao Nakazato

UNITED STATES

Commissioner-member.....Arnie J. Suomela, Chairman

Advisor-member.....H. E. Lokken

Advisor.....W. M. Terry

SECRETARIAT

Ex-officio members.....Roy I. Jackson
Hiroshi Kasahara

2. STANDING COMMITTEE ON BIOLOGY AND RESEARCH

CANADA

Commissioner-member.....James C. Cameron, Chairman

Advisor-members.....A. W. H. Needler
F. Neave

JAPAN

Commissioner-member.....Kyuhei Suzuki

Advisor-members.....Motosaku Fujinaga, Convenor
Kisaburo Taguchi

UNITED STATES

Commissioner-member.....John H. Clawson

Advisor-members.....D. L. McKernan
W. F. Thompson

SECRETARIAT

Ex-officio members.....Roy I. Jackson
Hiroshi Kasahara

3. AD HOC COMMITTEE ON ABSTENTION

CANADA

Commissioner-member	George R. Clark, Chairman
Commissioner-advisor	James C. Cameron
Advisors	A. W. H. Needler
	M. P. Shepard
	K. S. Ketchen
	F. H. C. Taylor
	D. B. DeLury
	W. M. Sprules
	R. Duder

UNITED STATES

Commissioner-member	Edward W. Allen
Commissioner-advisors	Milton E. Brooding
	Arnie J. Suomela
Advisors	D. L. McKernan
	W. C. Herrington
	C. E. Atkinson
	W. M. Terry
	R. A. Fredin
	H. E. Lokken
	R. C. Kallenberg

JAPAN

Commissioner-member	Iwao Fujita
Commissioner-advisors	Kenjiro Nishimura
	Kyuhei Suzuki
Advisors	Yoshimasa Sakamura
	Motosaku Fujinaga
	Keisuke Arita
	Kei Miyakawa
	Hisao Nakazato
	Tohru Sone
	Hiroshi Ohki (Alternate, Chusei Yamada)
	Toshio Isogai
	Motonobu Inagaki
	Yoshiji Shigeta
	Tomonari Matsushita
	Yoshio Fukuda
	Nobuhiko Hanamura
	Fukuzo Nagasaki
	Shoichi Tanaka
	Kisaburo Taguchi

4. AD HOC COMMITTEE ON THE PROTOCOL

CANADA

Commissioner-member	George R. Clark, Chairman
Commissioner-advisor	John M. Buchanan
Advisors	A. W. H. Needler
	W. M. Sprules

UNITED STATES

Commissioner-member	Milton E. Brooding
Commissioner-advisor	Edward W. Allen
Advisors	D. L. McKernan
	W. C. Herrington
	W. M. Terry
	W. F. Thompson

JAPAN

Commissioner-member	Kenjiro Nishimura
Commissioner-advisor	Iwao Fujita
Advisors	H. Okuhara
	Y. Sakamura
	M. Fujinaga
	K. Arita
	K. Miyakawa
	H. Nakazato
	T. Sone
	H. Ohki
	M. Inagaki
	T. Isogai

APPENDIX II

AGENDA

as adopted at the

FIFTH ANNUAL MEETING — 1958

Tokyo, Japan, November 4 to 10, 1958

1. Call to order
2. Introductions
3. Addresses of welcome and responses
4. Adoption of Agenda
5. Report on delegation memberships
6. Meeting procedures
   - (a) Attendance at sessions
   - (b) Schedule of sessions
   - (c) Press policy
   - (d) Minutes
7. Report of the Chairman
8. Report of the Secretary
9. Submission of reports by the Executive Director, including:
   - (a) Accounts and audit
   - (b) Budgets
   - (c) Administrative matters
   - (d) Second report on penalties for violations of the Convention (Article III(1)(d))
10. Consideration of terms of reference for the Ad Hoc Committee on the Protocol
11. Consideration of salmon problems in high seas areas of intermingling
12. Consideration of various matters previously referred to the Committee on Biology and Research
    - (a) Article III(1)(c)(i)—(king crab) (research phase)
    - (b) Article III(1)(c)(iii)—(form and nature of reports)
    - (c) Article III(1)(e)—(statistics)
    - (d) Publication of scientific reports
    - (e) Other matters
13. Report of the Committee on Biology and Research
14. Implementation of Article III(1)(a) of the Convention with respect to the stocks listed in the Annex:
    - (a) Halibut (Annex par. 1(a))
    - (b) Herring (Annex par. 1(b))
    - (c) Salmon of the northeastern North Pacific (Annex par. 1(c))
    - (d) Salmon of the eastern Bering Sea (Annex par. 2)
15. Consideration of procedures for implementing Article III(1)(a) in future years
16. Report of the Ad Hoc Committee on Abstention
17. Implementation of the Protocol
    - (a) Research phase
    - (b) Application of results of research
18. Report of the Ad Hoc Committee on the Protocol
19. Implementation of Article III(1)(c)(ii) with respect to king crab
20. Consideration of administrative and fiscal matters
    - (a) Accounts and auditors' report
    - (b) Budget for fiscal year beginning July 1, 1959
    - (c) Budget forecast for fiscal year beginning July 1, 1960
    - (d) Schedule of meetings for the forthcoming year
    - (e) Other business
21. Report of the Committee on Finance and Administration
22. Election of Officers
23. Other business
24. Adjournment

II. ADMINISTRATIVE REPORT FOR 1958

by the Executive Director
ROY I. JACKSON

This report contains information on fiscal and administrative matters and a record of the activities of the Secretariat of the International North Pacific Fisheries Commission for the period beginning with the close of the Fourth Annual Meeting of the Commission on November 8, 1957 and ending with the adjournment of the Fifth Annual Meeting on November 10, 1958.

1. OFFICERS AND STAFF

The Rules of Procedure of the Commission provide that officers of the Commission and its standing committees shall begin their terms upon adjournment of an annual meeting and continue until adjournment of the subsequent annual meeting. Representation in each of the offices rotates between representatives of the three member countries. Chairman of the Commission for the term which began at the adjournment of the 1957 Annual Meeting was Mr. Iwao Fujita of Japan; Vice-Chairman, Mr. Edward W. Allen of the United States; Secretary, Mr. George R. Clark of Canada. For the same term, the Chairman of the Standing Committee on Biology and Research was Mr. James C. Cameron of Canada and the Chairman of the Standing Committee on Finance and Administration was Mr. Ross L. Leffler of the United States, until October 9, 1958, when he was succeeded on the Commission by Mr. Arnie J. Suomela.

There were no changes in personnel in the Commission's Secretariat.

2. ACCOUNTS AND AUDIT

The report of the Commission's auditors, Peat, Marwick, Mitchell & Co., for the financial year ended June 30, 1958 is attached to this report as Appendix I.

Each Contracting Party contributed $13,076.66 toward the operating expenses of the Commission, making a total of $39,229.98 in contributions. In addition, interest earned on the Working Capital Fund, totalling $95.98, was credited to general funds in accordance with Financial Regulation 7.1. Total of funds available was thus $39,325.96. In this fiscal period, for the first time, appropriations were paid in Canadian funds. This resulted from amendment of Financial Regulation 5.4. The sum of $2,848.39 was held over into the 1958-59 fiscal period as a reserve for accounts payable, accrued expenses and legal obligations from the 1957-58 fiscal year. These accounts were received and paid by mid-October and there is therefore no surplus from 1957-58 appropriations.

A financial bond, in the amount of $25,000.00 was continued on all permanent staff members. The bond is in the hands of Mr. George R. Clark, Deputy Minister of Fisheries for Canada, for safekeeping.

3. WORKING CAPITAL FUND

The Working Capital Fund, amounting to $5,864.75, Canadian funds, was used once during the fiscal period 1957-58. Failure of any of the Contracting Parties to forward their contributions for the second half of the fiscal period until some time after the due date of January 1, 1958, necessitated transfer of $1,500.00 to the General Fund from the Working Capital Fund, in order to defray routine operating expenses. The funds were transferred on January 10, 1958 and returned to the Working Capital Fund on January 16, 1958 following receipt of a contribution from a Contracting Party. The Executive Director is authorized to make such advances from the Working Capital Fund on the condition that the advances be reimbursed as soon as contributions are received.

4. VOTES

During the period between the 1957 and 1958 annual meetings, the Commission voted by correspondence on various questions. The decisions and the dates on which they were announced or otherwise took effect are as follows:

(a) All national sections gave approval to the second draft of the summary minutes of the fifth plenary session of the 1957 Annual Meeting. Approval had been received from all national sections by February 8, 1958.

(b) Minutes of an *in-camera* session of the Commission held on November 8, 1957 were approved. Approval was announced in Circular Letter No. 41, dated June 2, 1958.

(c) All national sections agreed that an interim meeting of the Ad Hoc Committee on Abstention should be held in Honolulu beginning on August 7, 1958. The decision was announced in Circular Letter No. 43, dated June 12, 1958.

(d) All national sections of the Commission gave their approval to INPFC Doc. No. 166, "Report of the Organizing Session of the Second Ad Hoc Committee." Approval was announced in Circular Letter No. 44, dated July 9, 1958.

(e) All national sections of the Commission approved, for publication, a draft of the Annual Report for 1957, INPFC Doc. No. 169. Approval was announced in Circular Letter No. 47, dated July 30, 1958.

(f) All national sections gave their approval to name changes for the Commission's two ad hoc committees. The Ad Hoc Committee for Study of Reports Submitted Under Article III(1)(a) became the "Ad Hoc Committee on Abstention." The Second Ad Hoc Committee became the "Ad Hoc Committee on the Protocol." Approval was announced in Circular Letter No. 54, dated September 19, 1958.

(g) The Commission approved the issuing of invitations to the following organizations to be represented by observers at the 1958 Annual Meeting of the Commission at open plenary sessions and open sessions of its standing committees.

Food and Agriculture Organization of the United Nations

International Pacific Halibut Commission

International Pacific Salmon Fisheries Commission

Inter-American Tropical Tuna Commission

Union of Soviet Socialist Republics

5. CHANGES IN MEMBERSHIP OF THE NATIONAL SECTIONS

Mr. Koh Chiba of Japan resigned from the Commission on Dec. 16, 1957 and was succeeded on the same date by Mr. Haruki Mori. Mr. Mori also succeeded Mr. Chiba as offical correspondent of the Japanese Section.

Mr. Ross L. Leffler of the United States resigned from the Commission on October 9, 1958 and was succeeded by Mr. Arnie J. Suomela on the same date.

6. INTERIM MEETINGS

The last session of the 1957 Annual Meeting adjourned on November 8, 1957. The first preliminary committee meeting of the 1958 Annual Meeting began on October 20, 1958. In the interval between these sessions, meetings of two committees were held. On November 9, 1957 a new committee, now known as the Ad Hoc Committee on the Protocol, held an organizational meeting. The meeting, held in Vancouver, B.C., was for the purpose of discussing plans for the organization and activities of the newly-formed group. The committee, whose purpose is to consider application of the results of research to adjustment of the provisional lines in accordance with the terms of the Protocol, will not receive its terms of reference until the 1958 Annual Meeting. A report on the Committee's organizational activities was submitted to and approved by the Commission.

Another committee, now called the Ad Hoc Committee on Abstention, met in Honolulu from August 7 to 11, 1958. The purpose of the meeting was to prepare for the determinations which the Commission is expected to make at the 1958 Annual Meeting as to whether stocks of fish now under abstention should be removed from abstention. Both ad hoc committees met under the chairmanship of Mr. George R. Clark of Canada.

During the Honolulu meeting of the Ad Hoc Committee on Abstention, members of the Commission present discussed informally the various other problems which will be of concern to the Commission at the 1958 Annual Meeting. Although no formal actions were considered or taken, the discussions contributed to mutual understanding which should facilitate the 1958 Annual Meeting.

7. STAFF ACTIVITIES

At its headquarters in Vancouver, Canada, the Secretariat has continued its normal activities throughout the year. These activities have included drafting of reports, compilation of statistics, preparation of minutes and proceedings, reports on special subjects referred to the Executive Director, extensive correspondence between sections of the Commission and the Contracting Parties in connection with routine Commission business, preparation of agendas, commentaries and other documents related to meetings and continuous correspondence in connection with the Commission's research program, exchange of data, etc.

Bound copies of the Proceedings of the 1957 Annual Meeting were prepared and distributed to persons designated by each national section, shortly after the close of the sessions. A Japanese-language version of the Proceedings was prepared later in the year. Arrangements for such translations

are made by the Japanese National Section at the request and expense of the Secretariat.

The Japanese-language version of the Annual Report for 1956 and the English version of the Annual Report for 1957 were prepared, printed and distributed; the former with the assistance of the Japanese National Section. The Secretariat has compiled and reproduced a statistical yearbook for 1957, containing catch statistics for the important fisheries of joint interest in the Convention area. Data and tables for the compilation have been provided by the statistical agencies of the various countries. In addition, similar statistics for the years 1952 through 1956 are being re-arranged, checked for errors and omissions and reprinted in separate volumes. By the end of the calendar year 1958, the Secretariat expects to have in the hands of the Commissioners and others interested, the first six volumes of the statistical yearbook series, covering the years 1952 to 1957, inclusive.

No scientific bulletins have been published by the Commission during this period. However, in accordance with policy established at the 1957 Annual Meeting, three short scientific papers dealing with various aspects of Commission research have been submitted to scientific referees designated by each national section for approval for publication. Sufficient time has not yet elapsed to establish whether this procedure will result in production of comprehensive and timely research bulletins.

Quarterly newsletters containing information on subjects of interest to the Commission have been prepared and distributed by the Secretariat.

Members of the Secretariat have traveled extensively during the year in connection with Commission affairs. In November, 1957 the Executive Director attended the Annual Meeting of the Pacific Marine Fisheries Commission in Portland, Oregon, as an observer for this Commission. Various matters of general interest to this Commission were discussed at this meeting. In February, 1958, the Executive Director traveled to Washington, D.C., and Ottawa, Canada, to discuss Commission problems with representatives of the Commission and other fisheries officials in those cities. In March, 1958 the Assistant Director, accompanied by his family, traveled to Japan, combining home leave and preliminary preparations for the 1958 Annual Meeting. In May, 1958, the Director visited Japan to complete arrangements for the interim meeting of the Ad Hoc Committee on Abstention, which was held in Honolulu beginning on August 7, 1958. In September, 1958, the Director made a brief trip to Washington and Ottawa to discuss the various matters related to the preparations for the 1958 Annual Meeting of the Commission.

During the course of the year the Director and the Assistant Director have made a number of visits to the Pacific Biological Station at Nanaimo and the Bureau of Commercial Fisheries Laboratories at Seattle to discuss progress in Commission research and to assist in co-ordination of various phases of the work, exchange of data between the three national sections, etc.

The Secretariat had expected to move into new quarters being built on the University of British Columbia campus for the Vancouver Technological Laboratory of the Fisheries Research Board of Canada by mid-1958. Unavoidable delays in construction have postponed completion of the building until approximately the end of the year. The staff, therefore, does not expect to be installed in its new quarters until sometime in December, 1958, barring further delays.

8. BUDGET ESTIMATES

As required by the Financial Regulations, budget estimates for 1959-60 and a budget forecast for 1960-61 have been prepared in consultation with the Chairman of the Commission. The estimates and forecast have been distributed to all members of the Commission sixty days in advance of the 1958 Annual Meeting.

9. APPENDICES

The following reports and documents are submitted to the Commission with this administrative report:

1. Report of the Commission's auditors (INPFC Doc. 194)
2. Budget estimates and forecast (INPFC Doc. 191)
3. Statistical Yearbook, 1957 (INPFC Doc. 199)
4. Comments on the Form and Nature of the Reports Submitted Under Articles III (1)(c)(iii) and X(2) of the North Pacific Convention (INPFC Doc. 203)
5. Report on the Use of Working Capital Funds in Other International Fisheries Organizations (INPFC Doc. 204)

APPENDIX I

PEAT, MARWICK, MITCHELL & CO.
Chartered Accountants
410 Seymour Street
Vancouver 2
B.C.

AUDITORS' REPORT TO THE COMMISSION

We have examined the statement of assets and liabilities of the International North Pacific Fisheries Commission as of June 30, 1958, and the statements of income and expenditure and receipts and disbursements for the year ended on that date and have obtained all the information and explanations we have required. Our examination included a general review of the accounting procedures and such tests of accounting records and other supporting evidence as we considered necessary in the circumstances.

In our opinion the statement of assets and liabilities and statements of income and expenditure and receipts and disbursements are properly drawn up so as to exhibit a true and correct view of the state of the affairs of the Commission at June 30, 1958, and the results of its operations for the year ended on that date, according to the best of our information and the explanations given to us and as shown by the books of the Commission.

PEAT, MARWICK, MITCHELL & CO.
Chartered Accountants

Vancouver, B. C.
August 11, 1958.

Statement of Assets and Liabilities
June 30, 1958
(Stated in Canadian Funds)

Assets

General Funds:		
Cash in bank		$ 2,423.39
Deposit with United Air Lines		425.00
		2,848.39
Working Capital Fund:		
Cash in bank		5,864.75
Equipment, at cost	$ 5,018.23	
Less accumulated depreciation	1,524.43	
		3,493.80
		$12,206.94

Liabilities

General Funds:		
Accounts payable and accrued expenses		$ 2,848.39
Advances from contracting parties for working capital fund		5,864.75
Amount equivalent to expenditure on equipment less depreciation, per contra:		
Amount at June 30, 1957	$ 4,545.68	
Additions during the year	472.55	
	5,018.23	
Deduct:		
Depreciation provided in previous years	$ 1,022.61	
Depreciation in current year	501.82	
	1,524.43	
		3,493.80
		$12,206.94

Statement of Income and Expenditure
Year Ended June 30, 1958
(Stated in Canadian Funds)

Income:		
Contributions from contracting parties		$ 39,229.98
Interest earned on working capital fund bank account		95.98
		39,325.96
Expenditure:		
Personal services	$ 23,932.01	
Travel	6,319.56	
Transportation of things	278.21	
Communications	1,112.77	
Rent and utilities	1,500.00	
Other contractual services	3,101.61	
Supplies	1,254.60	
Equipment	472.55	
Cost of annual meeting	1,354.65	
		$39,325.96

Status of Appropriations

	Budget Appropriations Canadian Funds	Appropriations as Modified by Transfers Canadian Funds	Expenditures
Personal services	$24,280.00	$23,932.01	$23,932.01
Travel	6,000.00	6,319.56	6,319.56
Transportation of things	200.00	278.21	278.21
Communications	1,200.00	1,112.77	1,112.77
Rent and utilities	1,500.00	1,500.00	1,500.00
Other contractual services	3,095.96	3,101.61	3,101.61
Supplies	1,200.00	1,254.60	1,254.60
Equipment	1,000.00	472.55	472.55
Cost of annual meeting	850.00	1,354.65	1,354.65
	$39,325.96	$39,325.96	$39,325.96

Note:
The budget appropriation for "Other contractual services" has been adjusted to include $95.98 received in interest on the working capital fund and a deficiency of $0.02 in the total contributions received from the contracting parties.

Statement of Receipts and Disbursements
Year Ended June 30, 1958
(Stated in Canadian Funds)

Receipts:		
Contributions from contracting parties		$39,229.98
Interest on working capital fund bank account		95.98
		39,325.96
Disbursements:		
Personal services	$ 23,932.01	
Travel	5,460.59	
Transportation of things	278.21	
Communications	1,112.77	
Rent and utilities	1,500.00	
Other contractual services	3,822.24	
Supplies	1,254.60	
Equipment	472.55	
Cost of annual meeting	1,354.65	39,187.62
Excess of receipts over disbursements represented by increase in bank accounts:		
Balance, June 30, 1958	8,288.14	
Balance, June 30, 1957	8,149.80	
		$ 138.34

III. THE RESEARCH PROGRAM OF THE NORTH PACIFIC FISHERIES COMMISSION

A. PROGRESS IN 1958 IN CANADIAN RESEARCH ON PROBLEMS RAISED BY THE PROTOCOL

As part of the Commission's program of research on problems raised by the Protocol, Canada continued the following lines of investigation in 1958: (1) high-seas fishing to study salmon distribution and obtain samples for study, (2) studies of the parasites of sockeye and pink salmon and of chum salmon scales, to distinquish stocks of various river origins and discover their distribution on the high seas, and (3) study of the oceanography of the North Pacific to provide background for understanding salmon distribution and movements and their variations. Canada also co-operated in other phases of the program by providing material for study by United States and Japan and by efforts to recover tags placed on salmon on the high seas. Studies of the skeletal anatomy of salmon are being discontinued but preparation of reports is extending into 1959.

1. HIGH-SEAS FISHING TO STUDY DISTRIBUTION AND OBTAIN SAMPLES

Canada's high-seas fishing operations in 1958 were carried out by the *Key West II* and the *Fort Ross*. The ships left Nanaimo on May 7 and returned from their final cruises on August 28 and 25 respectively.

The fishing gear consisted mainly of surface gillnets, of mesh size 5¼", 4½", 3¼" and 2½", as used in 1957. A maximum of thirty-six 50-fathom shackles of this gear was set at one time. Additional surface gear carried in 1958 included 9" and 6¼" gillnets, each 200 fathoms long. Each vessel also carried a net capable of being fished at various depths below the surface. This net was 40 feet in depth and consisted of 100 fathoms of 2½" mesh, 100 fathoms of 3¼" mesh and 200 fathoms of 4½" mesh.

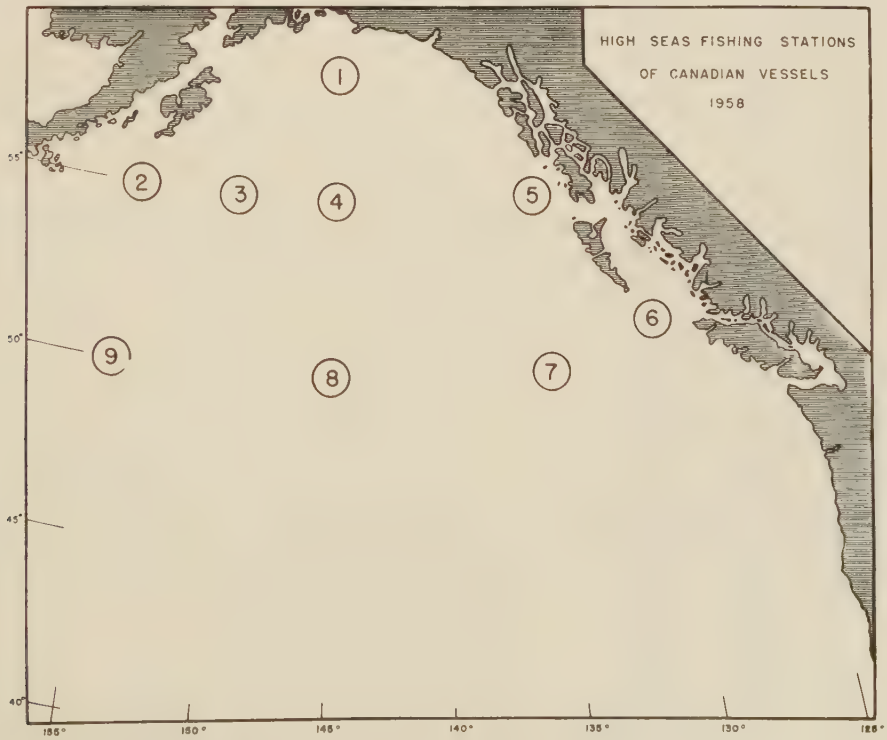


FIGURE 1. High seas fishing stations of Canadian vessels, 1958

Plankton and oceanographic observations, the latter limited to temperature and salinity, were also made in association with the high-seas fishing. Plankton nets were similar to those used in 1957. In 1958, however, mid-water trawls of Isaacs-Kidd pattern were also used.

Fishing was done at 9 stations within a region bounded on the south by latitude 50° N., on the west by longitude 155°W. and on the north and east by the North American coastline (Fig. 1). All these stations were occupied during the earlier part of the season (May-June) and all except Station 3 were again occupied briefly between the end of July and the end of August. In addition to these high-seas stations, a few sets were made at the end of July by the *Key West II* in coastal waters near the west coast of the Queen Charlotte Islands.

Much unfavourable weather was encountered during the fishing season. Because of this and related time losses occasioned by loss or damage of gear, the actual time spent in fishing was less than in 1957. Only 38 surface sets (excluding coastal operations) were made by the two vessels, as against 70 in the previous year. The number of successful sets was reduced especially during the late summer coverage of the high-seas stations.

Salmon Catches and Distribution. Catches and associated data for each set are shown in Table 1. The composition of the total catch by species is shown in Table 2, where comparative information for 1957 and 1956 is given. A main feature of the 1958 catch was the greatly increased percentage of sockeyes, with a corresponding reduction in the relative abundance of all the other species, except chinook which appeared in very small numbers each year.

In Table 3 the early summer catches for each station are summarized, after weighting for amount of gear used and length of time for which nets were set. Sockeye abundance increased with distance north and west from the British Columbia coast.

TABLE 1. Salmon catches by Canadian research vessels in 1958.

	Date	Position		No. of shackles	Surf. temp. (°C)	Depth interval (ft.)	Salmon					
		Lat.(°N)	Long.(°N)				Sockeye	Pink	Chum	Coho	Chinook	Total
Key West II												
Surface nets	May 11	51°00′	130°00′	44	10.1		3	2	1	1	..	7
" "	17	50°00′	135°00′	40	8.7		1	2	..	9	..	12
" "	18	50°00′	135°00′	40	9.4		5	10	64	21	..	100
" "	19	50°00′	135°00′	40	9.5		1	1	8	4	..	14
" "	28	51°00′	130°00′	40	11.1		3	7	5	6	..	21
" "	June 1	55°00′	145°00′	44	8.5		33	4	15	1	..	53
" "	2	55°00′	145°00′	38	8.7		25	5	4	..	..	34
" "	4	58°00′	145°00′	32	10.1		113	7	26	..	..	146
" "	5	58°00′	145°00′	32	10.2		137	31	19	2	..	189
" "	13	55°00′	135°00′	32	11.0		..	..	..	3	..	3
" "	14	55°00′	135°00′	36	11.1		1	..	..	..	..	1
" "	15	55°00′	135°00′	36	11.6		31	81	23	23	..	158
" "	16	55°00′	135°00′	36	11.7		3	6	5	9	..	23
" "	Aug. 8	51°00′	130°00′	4*	14.9		21	..	2	..	..	23
" "	9	50°00′	135°00′	4*	15.5		..	..	..	..	..	..
" "	15	55°00′	135°00′	4*	14.8		..	..	1	..	..	1
" "	16	55°00′	135°00′	12	14.3		1	..	..	..	..	1
" "	23	58°00′	145°00′†	12	14.7		..	..	..	..	..	..
" "	24	58°00′	145°00′†	4*	13.9		..	..	6	1	..	7
Sunken nets	May 17	50°00′	135°00′		8.7	60-100	..	..	..	1	..	1
" "	18	50°00′	135°00′		9.4	140-180	1	..	1	..	..	2
" "	19	50°00′	135°00′		9.5	60-100	..	..	..	..	..	..
" "	28	51°00′	130°00′		11.1	20-60	..	..	..	..	..	..
" "	June 1	55°00′	145°00′		8.5	20-60	2	..	2	..	..	4
" "	2	55°00′	145°00′		8.7	60-100	..	..	..	..	..	..
" "	4	58°00′	145°00′		10.1	20-60	21	1	4	..	..	26
" "	5	58°00′	145°00′		10.2	60-100	9	..	..	..	..	9
" "	14	55°00′	135°00′		11.1	20-60	..	..	..	..	..	..
" "	16	55°00′	135°00′		11.7	60-100	..	..	..	..	..	..
" "	Aug. 7	51°00′	130°00′		15.2	0-40	..	..	..	..	..	..
" "	8	51°00′	130°00′		14.9	20-60	15	..	..	..	..	15
" "	9	50°00′	135°00′		15.5	20-60	..	..	..	..	..	..
" "	15	55°00′	135°00′		14.8	20-60	2	..	..	..	..	2
" "	16	55°00′	135°00′		14.3	0-40	12	..	2	1	..	15
" "	23	58°00′	145°00′†		14.7	0-40	..	..	..	..	..	..
" "	24	58°00′	145°00′†		13.9	20-60	..	..	4	..	..	4

Continued . . .

TABLE 1. (continued) Salmon catches by Canadian research vessels in 1958.

	Date	Position		No. of shackles	Surf. temp. (°C)	Depth interval (ft.)	Salmon					
		Lat.(°N)	Long.(°N)				Sockeye	Pink	Chum	Coho	Chinook	Total
Fort Ross												
Surface nets	May 17	50°00′	135°00′	36	9.6		3	3	1	5	..	12
" "	19	50°00′	135°00′	36	9.4		..	..	..	..	..	..
" "	24	50°00′	145°00′	36	7.6		41	4	15	2	1	63
" "	25	50°00′	145°00′	36	7.7		41	4	26	4	..	75
" "	27	50°00′	145°00′	35	7.9		78	11	45	..	..	134
" "	June 7	55°00′	150°00′	35	8.1		101	..	26	..	..	127
" "	8	55°00′	150°00′	35	7.8		37	1	8	..	..	46
" "	9	55°00′	150°00′	34	8.2		34	1	25	..	..	60
" "	10	55°00′	150°00′	32	8.3		155	5	12	..	..	172
" "	15	55°00′	155°00′	34	7.8		146	9	13	..	..	168
" "	16	55°00′	155°00′	18	7.4		35	1	3	..	..	39
" "	23	50°00′	155°00′	22	7.6		25	9	13	..	..	47
" "	24	50°00′	155°00′	22	7.8		61	3	41	..	3	108
" "	25	50°00′	155°00′	22	8.1		36	11	14	..	1	62
" "	26	50°00′	155°00′	1	8.5		1	..	..	..	..	1
" "	July 26	50°00′	145°00′	17	13.7		1	..	..	..	..	1
" "	Aug. 1	50°00′	155°00′	18	10.2		1	..	47	..	..	48
" "	15	55°00′	155°00′	14	11.0		3	1	25	2	..	31
" "	18	55°00′	145°00′	14	13.4		..	..	1	..	..	1
Sunken nets	May 17	50°00′	135°00′		9.6	20-60	..	..	1	..	..	1
" "	18	50°00′	135°00′		9.5	100-140	1	..	..	1	..	2
" "	24	50°00′	145°00′		7.6	20-60	4	..	2	..	..	6
" "	27	50°00′	145°00′		7.9	60-100	..	..	..	..	..	..
" "	June 7	55°00′	150°00′		8.1	60-100	3	..	1	..	..	4
" "	19	50°00′	155°00′		7.4	20-60	1	5	..	..	..	6
" "	23	50°00′	155°00′		7.6	20-60	1	1	..	..	..	2
" "	24	50°00′	155°00′		7.8	60-100	..	1	..	..	..	1
" "	26	50°00′	145°00′		13.7	0-40	..	..	..	..	..	..
" "	Aug. 1	50°00′	155°00′		10.2	0-40	..	..	1	..	..	1
" "	15	55°00′	155°00′		11.0	0-40	2	1	8	..	..	11
" "	18	55°00′	145°00′		13.4	20-60	..	..	1	..	..	1
Totals—*Fort Ross*							811	71	329	14	5	1230
Key West II							440	157	192	82	..	871
Grant Total							1251	228	521	96	5	2101
%							59.5	10.9	24.8	4.6	0.2	100.0

* 6¼" net. No standard surface nets used.
† Approximate position.

TABLE 2. Salmon catches in the Northeast Pacific.

Year	Sockeye		Pink		Chum		Coho		Chinook		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	
1956	200	21.2	250	26.5	349	37.0	139	14.7	5	0.5	943
1957	997	27.2	519	14.1	1798	48.9	357	9.7	5	0.1	3676
1958	1251	59.5	228	10.9	521	24.8	96	4.6	5	0.2	2101

TABLE 3. Surface catch per 900 fathoms of gillnet per 10-hours night set, with equal representation of 2½", 3¼", 4½" and 5¼" mesh.

Ship	Station	No. of sets	Position		Weighted catch (numbers of fish)					
			Lat. °N.	Long. °W.	Sockeye	Pink	Chum	Coho	Chinook	Total
KW	1	2	58	145	51	8	10	1	..	70
FR	2	2	55	155	62	2	4	..	..	68
FR	3	4	55	150	41	1	8	..	..	50
KW	4	2	55	145	10	2	4	1	..	17
KW	5	4	55	135	7	13	4	6	..	30
KW	6	2	51	130	2	3	2	2	..	9
KW, FR	7	4	50	135	1	2	7	3	..	13
FR	8	3	50	145	21	4	11	1	..	37
FR	9	3	50	155	34	4	14	..	1	53

Pink salmon were most plentiful at the northern and northeastern stations. Chum salmon (when all age groups are considered) were spread fairly evenly over the region sampled. Cohoes were commoner at the eastern stations, i.e. towards the coasts of British Columbia and southeast Alaska. Late-season sampling was too scanty to provide reliable information on distribution and abundance.

The sets made with the sunken nets are listed in Table 1. The catches are not considered to provide any reliable information on the relative abundance of salmon at different depths. Various difficulties in the use of the sunken nets were encountered. Unfavourable weather conditions curtailed the program. It proved difficult or impossible to fish the sunken net effectively in conjunction with the large amount of surface gear which was considered necessary to provide adequate samples. Certain features of the construction of the nets also militated against their successful operation. Further investigation of the vertical distribution of salmon is planned for 1959.

Age Composition. The age composition of sockeye and chums caught in the 1958 high-seas fishing operations is given in Tables 4 and 5.

Among sockeyes, 4_2 fish formed the largest age group at all stations except No. 1. The predominance of this group in high-seas catches preceded an extremely heavy run of fish of this category to the Fraser River, B.C. and it is thought that some of the sockeyes caught on the high seas as far west as longitude 155°W. were Fraser River fish. However, the increased high-seas sockeye catches of 1958 (as compared with 1957) were largely due to an increase in the number of 5th and 6th year fish. These presumably originated in northern British Columbia and Alaska.

Chum catches showed a preponderance of 3rd-year fish at the southern and western stations. In the earlier operations 4th-year fish were in a majority towards the northern and eastern shorelines. Fifth-year fish were not represented in the later catches.

Plankton and Feeding of Salmon. Plankton collections made by Canadian research vessels in 1958 included 260 vertical tows from 150 meters to the surface. These permit some comparison of the standing crop of zooplankton by region and time.

The seasonal pattern of the crop in the Gulf of Alaska shows a winter minimum extending from December until early March. After a very rapid increase in numbers in March and April, a maximum is attained in May or early June. August marks the summer minimum but August is the only month in which observations are sufficiently

TABLE 4. Age composition of sockeye catches in the Northeast Pacific, 1958.

Period	Station	Age													Unknown	Total
		2_1	3_1	3_2	4_1	4_2	4_3	5_2	5_3	6_2	6_3	6_4	7_3	7_4		
Early	1	..	..	1	..	54	3	126	38	..	33	12	1	1	11	280
	2	..	..	2	1	93	3	32	22	..	9	2	..	..	17	181
	3	..	..	1	..	160	2	79	38	..	28	2	..	1	19	330
	4	..	..	..	..	28	..	6	11	1	3	4	..	..	7	60
	5	5	..	2	..	9	..	6	3	..	..	..	..	..	10	35
	6	..	..	..	..	1	1	1	1	..	..	..	..	..	2	6
	7	..	..	..	..	7	..	..	4	..	..	..	..	..	1	12
	8	..	3	3	..	109	1	3	27	..	1	3	..	..	14	164
	9	..	..	34	1	61	12	2	6	1	..	..	..	..	8	125
	Totals	5	3	43	2	522	22	255	150	2	74	23	1	2	89	1193
	%	0.4	0.3	3.6	0.2	43.9	1.8	21.4	12.6	0.2	6.2	1.6	0.1	0.2	7.5	100.0
Late	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	2	..	..	..	..	2	2	..	1	..	..	..	..	..	..	5
	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	5	..	..	..	..	15	..	..	..	..	..	..	..	..	..	15
	6	..	..	..	..	30	..	2	4	..	..	..	..	..	..	36
	7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	8	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
	9	..	..	1	..	..	..	..	..	..	..	..	..	..	..	1
	Totals	..	..	1	..	48	2	2	5	..	..	..	..	..	..	58
	%	..	..	1.7	..	82.8	3.4	3.4	8.6	..	..	..	..	..	..	99.9

TABLE 5. Age composition of chum salmon catches in the Northeast Pacific, 1958.

Period	Station	Age					
		2	3	4	5	Unknown	Total
Early	1	..	8	32	5	4	49
	2	..	11	1	2	2	16
	3	..	38	23	5	6	72
	4	..	7	12	..	2	21
	5	13	1	9	..	5	28
	6	1	1	4	..	..	6
	7	3	61	3	..	8	75
	8	1	49	30	4	4	88
	9	..	44	19	1	5	69
	Totals	18	220	133	17	36	424
	%	4.3	52.0	31.4	4.0	8.3	100.0
Late	1	..	3	6	..	1	10
	2	7	22	3	..	1	33
	3	..	..	..	..	..	..
	4	..	1	1	..	..	2
	5	..	2	1	..	..	3
	6	..	..	2	..	..	2
	7	..	..	..	..	..	..
	8	..	..	..	..	..	..
	9	9	33	2	..	4	48
	Totals	16	61	15	..	6	98
	%	16.3	62.3	15.3	..	6.1	100.0

numerous and consistent to permit a year-to-year comparison over most of the Gulf of Alaska. Figure 2 indicates the relative size of the standing crop during this month in the years 1956, 1957 and 1958. It will be seen that 1956 and 1958 are essentially similar, while in 1957 the standing crop was approximately half as great. This reduction may have been due to greater cloud cover, which would tend to prevent full utilization of nutrients by the phytoplankton and thus limit zooplankton production.

Examination of sockeye and pink salmon stomachs indicates that these species in the Gulf of Alaska relied more on copepods and less on euphausians in 1957 than in 1956 or 1958, suggesting that the latter were at even a lower level than the smaller zooplankton.

Salmon Distribution and Water Temperatures. Studies of salmon and water temperature have shown the need for considering maturing and immature fish separately. In the Gulf of Alaska relatively good catches of maturing fish have been made in waters up to 15°C. Catches of immature sockeye and chum salmon, particularly the latter species, appear to be related to depth of the 5°, 6° and 7°C. isotherms. Where these isotherms are closer to the surface, catches are greater, the correlation being with the 6° isotherm.

Comprehensive Study of Salmon Distribution. Analysis of United States, Japanese and Canadian catch data collectively shows that the distribution of sockeye and chum salmon in the Bering Sea and North Pacific Ocean in 1956 differed to some extent from that in 1957. In general, in the latter year, the areas of abundance of these species in each month from May to September were located farther to the westward. It was also observed from the monthly distribution of surface isotherms for this period, based on data collected by the fishing and oceanographic vessels of each National Section, that the waters were warmer farther westward in 1957 than in 1956.

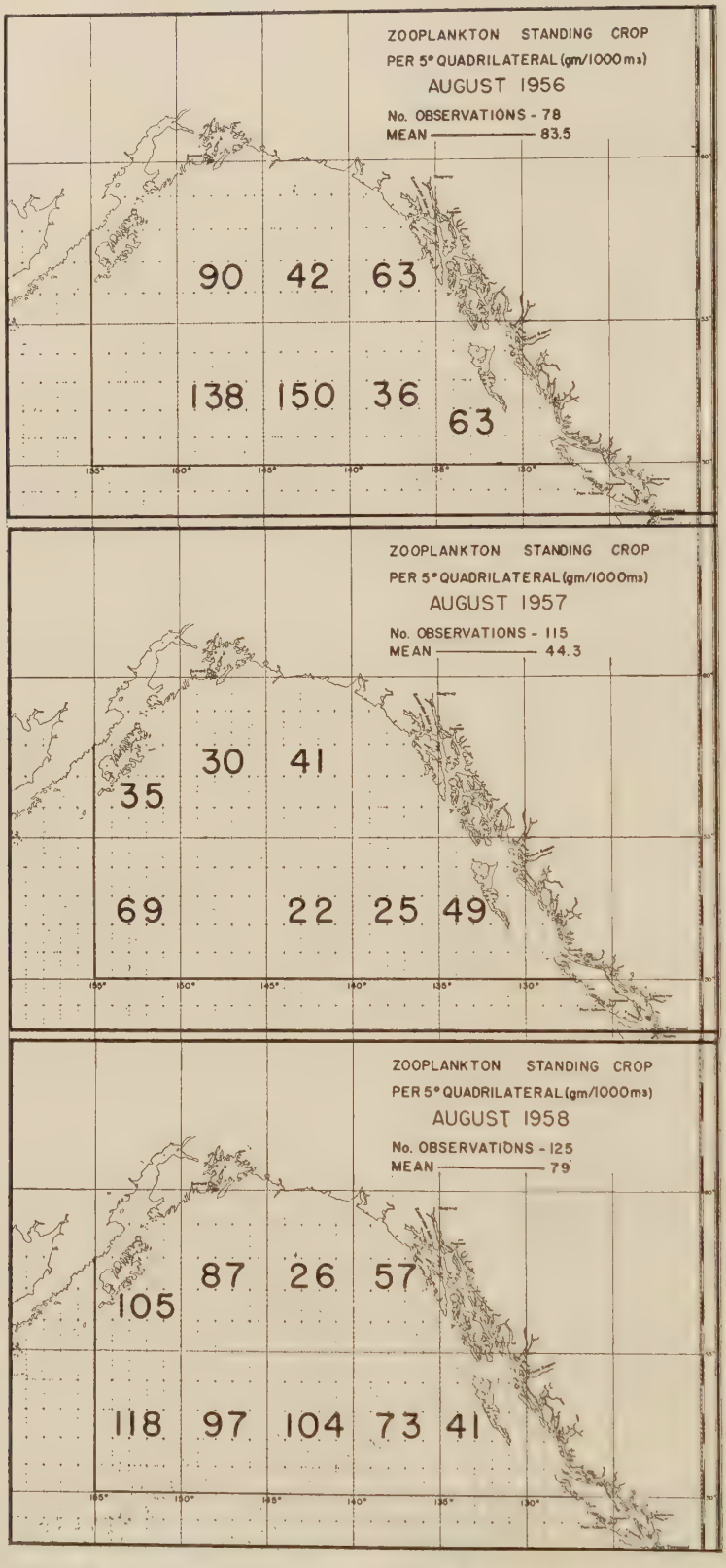


FIGURE 2. Zooplankton standing crop in Gulf of Alaska for the years 1956-1958

2. STUDY OF SALMON PARASITES TO DISTINGUISH STOCKS

A. Sockeye Salmon. Since 1955 investigations of the parasites of sockeye salmon have been underway to assess their value as indicators of the continent of origin of sockeye taken on the high seas.

Sampling of adult sockeye along the North American coast and of sockeye taken on the high seas increased from 1955 through 1957; smolt sampling from North America remained about the same for the 3 years. From 1957 collections, 1,903 adult or sub-adult sockeye were examined in samples from across the North Pacific and Bering Sea, from the Sea of Okhotsk and from the main spawning runs or fisheries of North America. Three hundred and fifty smolts were also examined from collections made in 1957. Details of the geographical location, date of catch and numbers of sockeye examined from each locality are given in Tables 6 and 7. Figure 3 also shows pictorially the distribution of coastal adult and high-seas samples in 1957.

Japan, United States and Canada have cooperated in providing samples of sockeye from the North Pacific and Bering Sea from research vessel operations. In addition, Japan has provided samples from commercial fishing operations in the North Pacific and Bering Sea west of 175° W. longitude, and in the Sea of Okhotsk. Adult sockeye from coastal areas, and smolts have been collected by the United States and Canada from various North American localities.

Of the six species of parasites listed in last year's annual report only four continue to give evidence of the continent of origin of sockeye infested with them. These are *Triaenophorus crassus* (acquired in fresh water) and *Tubulovesicula lindbergi* (acquired in the sea), characteristic of certain North American stocks, and *Dacnitis truttae* (acquired in fresh water) and *Hemiurus levinseni* (acquired in the sea), indicative of Asiatic origin.

TABLE 6. Locality, date of catch and size of coastal adult and high-seas sockeye samples examined for parasites in 1957. (The numbers preceding the locality refer to the numbered positions in Figure 3)

	Locality	Date of catch		Number of sockeyes		Locality	Date of catch		Number of sockeyes
1	50°52′N., 153°28′E.	4-VII	1957	25	31	53°N., 175°W.	9-VI	1957	25
2	51°16′N., 153°39′E.	14-VII	"	25	32	53°N., 175°W.	10-VI	"	24
3	52°08′N., 154°15′E.	24-VI	"	25	33	56°N., 175°W.	15-VI	"	40
4	49°14′N., 158°11′E.	10-VII	"	23	34	56°N., 175°W.	30-VI	"	21
5	51°13′N., 159°45′E.	24-VII	"	25	35	56°N., 173°W.	17-VI	"	25
6	51°33′N., 161°40′E.	20-VII	"	25	36	56°N., 170°W.	18-VI	"	25
7	51°39′N., 162°16′E.	1-VII	"	25	37	55°N., 168°W.	22-VI	"	30
8	52°33′N., 166°04′E.	20-VI	"	25	38	56°N., 168°W.	21-VI	"	16
9	48°08′N., 167°40′E	21-V	"	25	39	55°N., 166°W.	24-VI	"	14
10	51°40′N., 167°27′E.	28-VI	"	25	40	56°N., 166°W.	23-VI	"	19
11	52°31′N., 168°27′E.	25-V	"	25	41	50°N., 165°W.	9, 20, 21-VIII	"	24
12	58°12′N., 166°48′E.	15-VII	"	26	42	53°N., 165°W.	31-VII	"	15
13	57°02′N., 169°11′E.	12-VII	"	19	43	53°N., 165°W.	24-VII	"	25
14	54°51′N., 170°24′E.	6-VII	"	20	46	54°N., 160°W.	15-VII	"	27
16	50°N., 175°E.	12-VI	"	25	47	52°N., 160°W.	17-VII	"	25
17	50°N., 175°E.	10, 11, 12-VI	"	43	54	50°N., 155°W.	23-VI	"	22
18	50°N., 175°E.	9-VIII	"	25	55	50°N., 155°W.	30, 31-VII	"	25
19	50°N., 175°E.	20-VIII	"	25	56	55°N., 155°W.	30-VI	"	23
20	51°30′N., 175°E.	19-VIII	"	25	57	55°N., 155°W.	18, 19-VIII	"	25
21	53°N., 175°E.	14-VI	"	25	60	50°N., 145°W.	27, 29-VI	"	14
22	53°N., 175°E.	17-VIII	"	25	61	50°N., 145°W.	13-VI	"	23
23	56°N., 175°E.	14-VIII	"	24	62	55°N., 145°W.	11-VII	"	10
24	53°N., 180°	22-VI	"	25	63	55°N., 145°W.	28-VI	"	13
25	51°N., 176°W.	8-VII	"	25	64	58°N., 145°W.	9-VII	"	24
26	50°59′N., 175°10′W.	7-VIII	"	25	67	50°N., 135°W.	20-VII	"	23
27	50°59′N., 175°01′W.	22-VIII	"	25	68	50°N., 135°W.	2-VII	"	25
28	50°N., 175°W.	9-VIII	"	25	69	50°N., 135°W.	8-VI	"	21
29	50°N., 175°W.	20-VIII	"	25	70	55°N., 135°W.	30, 31-VII	"	20
30	53°N., 175°W.	8-VI	"	24	71	55°N., 135°W.	14-VI	"	25

TABLE 7. Locality, date of catch and size of sockeye smolt samples examined for parasites in 1957.

Locality	Date of catch		Number of sockeyes
Wood River, Bristol Bay, Alaska	11-VII	1957	25
Kvichak River, Bristol Bay, Alaska	31-V	"	25
Naknek River, Bristol Bay, Alaska	13 to 19-VI	"	25
Ugashik River, Bristol Bay, Alaska	22-V	"	25
Chignik Lake, Alaska Peninsula	4-VI	"	25
Karluk River, Kodiak Is., Alaska	26-V	"	25
Helm Bay, southeast Alaska	27-VI	"	25
Babine Lake, Skeena R., B.C.	30-V	"	25
Nilkitkwa Lake, Skeena R., B.C.	31-V	"	25
Port John, central British Columbia	19-V	"	25
Shushwap Lake, Fraser R., B.C.	May	"	25
Chilko River, Fraser R., B.C.	7-V	"	25
Cultus Lake, Fraser R., B.C.	26-V	"	25
Baker R., (Skagit R.) Washington	26-V	"	25
Total number of smolts in 1957			350

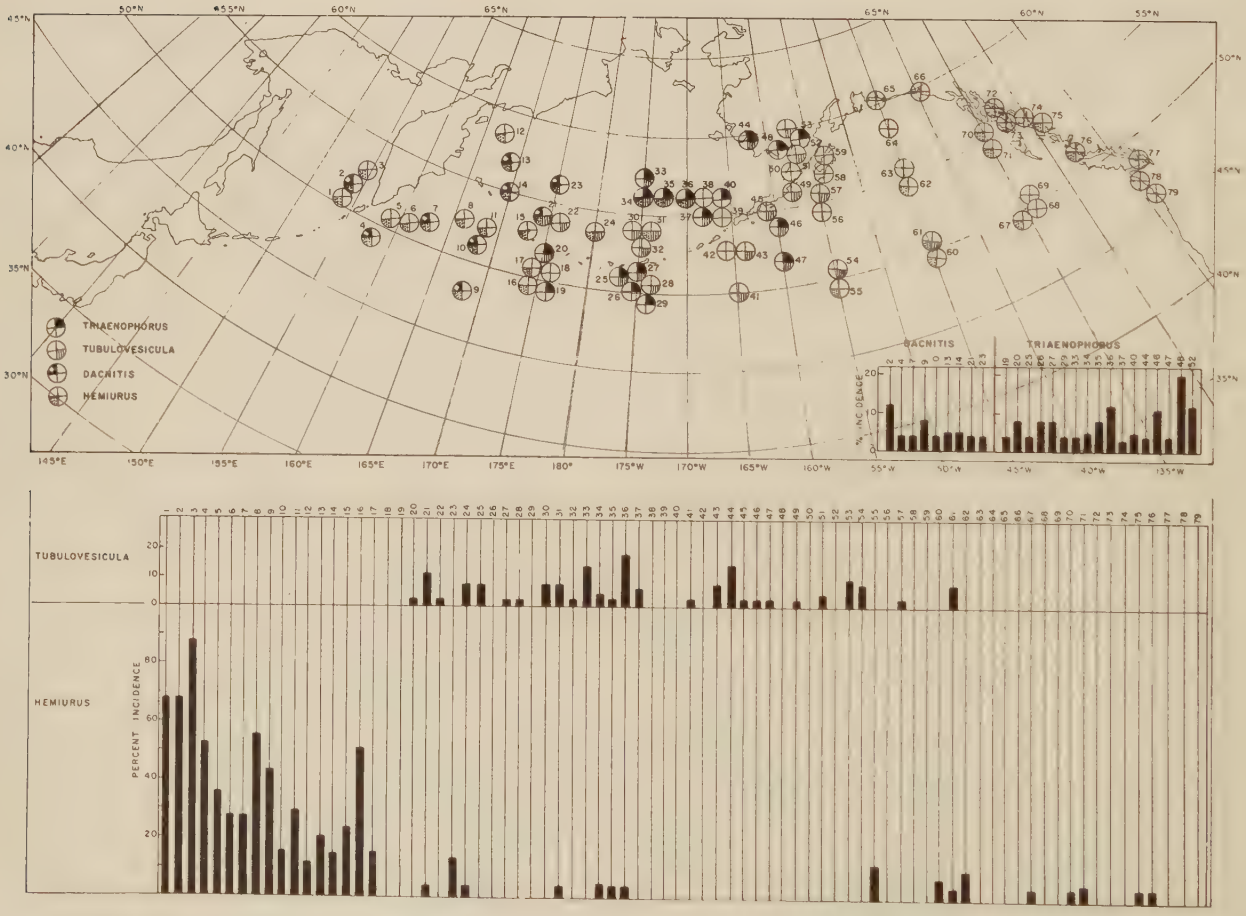


FIGURE 3. Distribution of sockeye salmon samples in 1957 with occurrence and incidence of *Triaenophorus*, *Dacnitis*, *Tubulovesicula* (mature) and *Hemiurus* in these samples.

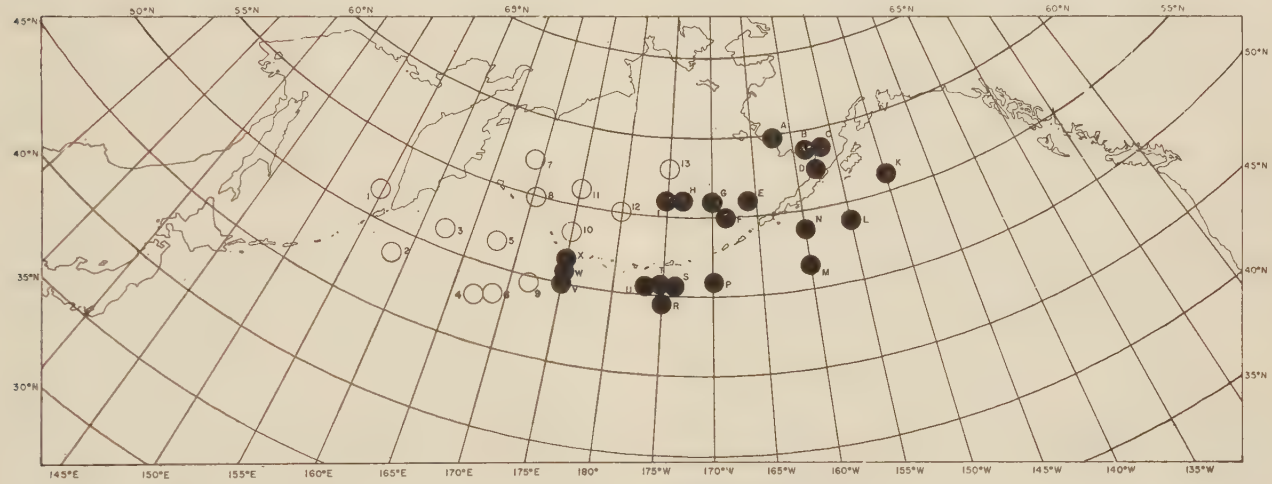
The occurrence of the latter parasite in some southeast Alaska and British Columbia areas will be discussed later. On the basis of the 1957 samples, larvae of *Anisakis* sp. and *Echinorhynchus gadi* no longer qualified as indicators of the continent of origin of sockeye captured on the high seas.

i. Distribution of Triaenophorus, Dacnitis, Tubulovesicula and Hemiurus in sockeye.

Triaenophorus crassus. This larval cestode, acquired by sockeye in fresh water, has been found in smolts and returning spawners only in certain areas in western Alaska, mainly in Bristol Bay. The specific localities in which *Triaenophorus* has been observed in the years 1955 through 1957 are the Wood River, Naknek River and Ugashik River in Bristol Bay, and the Kuskokwim River, north of Bristol Bay. The incidence is greatest in the Wood River, less in the Naknek River, and least in the Ugashik and Kuskokwim Rivers. In the high-seas samples it was observed from 150° W. longitude in the Gulf of Alaska to 175°E. longitude, south of the Aleutians, and from 175°W. longitude, eastward, in the Bering Sea. *Triaenophorus* was not observed west of 175°E. longitude in any of the three years of investigation.

The distribution and incidence of this parasite in the coastal adult and in the high-seas samples collected in 1957 are shown in Figure 3. Figure 4 illustrates the distribution of all sockeye (including smolts) infected with *Triaenophorus* from the years 1955 through 1957 and gives the incidence of *Triaenophorus* in each sample, the date of collection and the age of the infected sockeye.

Tubulovesicula lindbergi. Mature specimens of this marine trematode were found in some of the North American coastal samples, particularly in central and western Alaska, in all three years. On the high seas adult *Tubulovesicula* were observed in many of the sockeye samples south of the Aleutians, from 171°E. longitude to 150°W. longitude (rarely at 145°W.) in the Gulf of Alaska, and from 175°E. longitude to 165°W. longitude in the Bering Sea. They were absent from all samples examined from 170°E. longitude to the Sea of Okhotsk. (See Fig. 3.)



DACNITIS

	LOCALITY	% INFECTED	DATE	AGE
1	51°16'N., 153°39'E.	12	14/7/1957	5₂, 6₃(2)
	51°55'N., 154°13'E.	12	6/7/1956	5₂ (3)
	51°49'N., 154°06E.	8	21/6/1956	5₃, 6₃
	51°22'-53°20'N., 153°50'-154°30'E.	8	30/6/1955 TO 10/8/1955	—
2	49°14'N., 158°11'E.	4	10/7/1957	6₄
3	51°39'N., 162°16'E.	4	1/7/1957	5₂
4	48°08'N., 167°40'E	8	21/5/1957	4₂, 5₂
5	51°40'N., 167°27'E.	4	28/6/1957	5₂
6	48°32'N., 167°50'E.	7	1/6/1955	—
7	57°02'N., 169°11'E.	5	12/7/1957	3₀₀
8	54°51'N., 170°24'E.	5	6/7/1957	5₂
9	49°35'N., 171°46'E.	4	6/7/1956	5₂
10	53°N., 175°E.	4	14/6/1957	—
11	56°N., 175°E.	4	14/8/1957	—
12	55°N., 180°	4	8/7/1956	5₃
13	58°N., 175°W.	4	15/7/1956	4₂

TRIAENOPHORUS

	LOCALITY	% INFECTED	DATE	AGE
A	KUSKOKWIM R	4	22/6/1957	6₃
B	WOOD R., BRISTOL BAY	37	20/6/1955	SMOLTS
		52	21/6/1956	〃 〃
		36	11/7/1956	4₂(4), 5₂(4), 6₃
		20	17/7/1957	4₂, 5₂ (4)
C	NAKNEK R., BRISTOL BAY	16	24/6 TO 15/7/1956	SMOLTS
		4	8/7/1956	5₂
		16	13 TO 19/6/1957	SMOLTS
		12	30/7/1957	5₂, 6₃, (2)
D	UGASHIK R., BRISTOL BAY	4	22/5/1957	SMOLTS
E	56°N., 166°W.	5	23/6/1957	6₃
F	55°N., 168°W.	3	22/8/1957	4₂
G	56°N., 170°W.	12	18/6/1957	5₂(2), 6₃
H	56°N., 173°W.	8	17/6/1957	5₂, 6₃
I	56°N., 175°W.	2.5	15/6/1957	6₃
		5	30/8/1957	6₃
K	58°N., 150°W.	4	16/7/1956	4₂
L	54°N., 155°W.	8	18/8/1956	4₂, 5₃
M	52°N., 160°W.	4	17/7/1957	3₂
N	54°N., 160°W.	11	15/7/1957	3₂, 4₃(2)
P	51°N., 170°W.	8	20/8/1956	5₃,(2)
R	50°N., 175°W.	4	20/8/1957	4₂
S	50°59'N., 175°01'W.	8	22/8/1957	4₂(2)
T	50°59'N., 175°10'W.	8	7/8/1957	4₂(2)
U	51°N., 178°W.	4	8/7/1957	4₂
V	50°N., 175°E.	4	20/8/1957	4₂
W	51°N., 175°E.	4	25/8/1956	5₃
X	51°30'N., 175°E.	8	19/8/1957	4₂(2)

FIGURE 4. Distribution of sockeye salmon infected with *Triaenophorus* and *Dacnitis* from 1955 to 1957.

Small, immature specimens of this species were also found in mature sockeye from some North American coastal areas, particularly in southeast Alaska and British Columbia. It appears that *Tubulovesicula* in these more southerly areas resulted from infection of the mature sockeye after re-entry into coastal waters, and the occurrence of immature *Tubulovesicula* cannot be considered to show relationship of these fish to high-seas sockeye infected with mature *Tubulovesicula.*

Dacnitis truttae. This nematode, with a freshwater life cycle, occurred in sockeye samples from the Okhotsk Sea to 172°E. longitude, south of the Aleutians, and to 175°W. longitude in the Bering Sea. It was not present in any of the high-seas samples east of these longitudes, nor in any of the North American coastal adult and smolt samples. The distribution and incidence of *Dacnitis* in the 1957 samples is given in Figure 3. Figure 4 shows the accumulated distribution of *Dacnitis*-infected sockeye for the three years, with data on incidence, date of catch and age of the fish.

Hemiurus levinseni. This marine trematode was noted in all high-seas samples in the three years, from the Sea of Okhotsk to 170°E. longitude, at latitudes between approximately 48°N. and 58°N. It occurred in some of the samples from 171°E. to 175°E. longitude, south of the Aleutians, and in many of the 1957 samples in the Bering Sea from 175°E. to 170°W. longitude. In the Bering Sea samples east of 175°E. to 170°W. its incidence was considerably less than in more westerly areas. South of the Aleutians and the Alaska Peninsula, *Hemiurus* was absent from all samples from 180° to 160°W. longitude. In the Bering Sea it was absent east of 170°W. longitude.

Hemiurus was found in the Gulf of Alaska, particularly from 150°W., eastward, but in a much lower frequency than in the western Pacific areas. In North American coastal areas it appeared regularly from 1955 through 1957 in some of the samples from southeast of Petersburg, Alaska (ca. 57°N., 133°W.), the incidence in these samples being similar to that in the Gulf of Alaska samples. With two exceptions, *Hemiurus* was absent from all central and western Alaska samples in the three years. In 1955 one sockeye infected with one specimen of *Hemiurus* was found in the Bristol Bay samples, and in 1956 a similarly infected sockeye was found in the sample from the Kuskokwim River, western Alaska.

The distribution and incidence of *Hemiurus* in the 1957 samples is shown in Figure 3.

ii. Are the selected parasites valid indicators of the geographical origin of sockeye taken on the high seas? Two of the four selected parasites are acquired in fresh water before the fish migrate to sea and apparently remain with the fish throughout its life. Because they are restricted in their distribution in sockeye to certain areas of one or other of the two continents they serve as excellent "tags" of the continent of origin of sockeye infected with them.

The other two parasites are acquired in the sea. Although the exact locality in which infection of sockeye by these parasites occurs, the age at which the sockeye become infected and the life span of the parasites in sockeye are unknown, the characteristics of their distribution suggest that they are of value in recognizing the high-seas distribution of stocks from the two continents.

Triaenophorus crassus. This is a larval (plerocercoid) cestode inhabiting the musculature of the sockeye. The life history involves a freshwater fish, *Esox lucius,* in the intestine of which it matures. After the parasite becomes gravid the eggs eventually reach the water where they hatch. The resulting embryos (coracidia) must be ingested by certain species of copepods, mainly *Cyclops,* for continued development. In the copepod they reach the first larval (procercoid) stage. Young sockeye acquire the parasite in fresh water by eating infected copepods, and *Esox* becomes infected by eating fish parasitized with the second larval stage. The important host in this cycle is *Esox.* The parasite will not mature in the intestine of other fishes and hence larval *Triaenophorus crassus* can only occur in sockeye in lakes co-inhabited by *Esox.*

The absence of *Esox* from Pacific drainages (as distinct from Bering Sea drainages) of North America and from the Kamchatka Peninsula, precludes the possibility of the occurrence of this parasite in sockeye from these areas. The absence of *Triaenophorus* from sockeye from North American Pacific drainages has been confirmed by examination of smolts and adults from many localities. Smolts or adults from inshore waters were not available from Kamchatka but the samples from the Sea of Okhotsk and from the far-western Pacific and Bering Sea were all free of *Triaenophorus.* Also, in recent studies of parasites of sockeye from Kamchatka by scientists in the U.S.S.R., *Triaenophorus* is not noted. On the other hand, observations from 1955 through 1957 have indicated that smolts from, and adults returning to, certain western Alaska areas (mainly Bristol Bay) are infected with *Triaenophorus.* Since the parasite cannot be acquired in the sea, the *Triaenophorus* in sockeye returning to spawn after two or three years in the ocean are the same that were acquired in fresh water.

It is concluded that sockeye caught on the high seas, which are infected with *Triaenophorus,* must be of western Alaskan origin, apparently mainly from Bristol Bay.

Dacnitis truttae. This nematode has a freshwater life cycle and lives in the intestine of salmonoid fishes. The intermediate host or hosts, in which larval development takes place, and which transmit the parasite to sockeye, are apparently unknown, but it is presumed that only one intermediate host is required, which is probably an aquatic arthropod.

The parasite was found in the Sea of Okhotsk sockeye samples in each of the years 1955 through 1957 and in many of the sampled localities in the western Pacific and Bering Sea. Recent publications from the U.S.S.R. record *Dacnitis* as a parasite of the sockeye from Kamchatka. The occurrence of this freshwater parasite in sockeye of age 5_2 or 6_3, taken on the high seas, indicates an ability to live in sockeye for at least 3 to 4 years. *Dacnitis* was not found in any of the smolts from, or adults returning to, North American localities. It appears then, that sockeye taken on the high seas parasitized by *Dacnitis* have acquired the parasite in Kamchatka.

Tubulovesicula lindbergi. This is a marine trematode which occurs as an adult in the stomach of sockeye and other fishes. Its life history is unknown, but like practically all other trematodes the first intermediate host is almost certainly a mollusc and probably a gastropod. A second intermediate host which carries the stage infective to sockeye, is probably involved and is probably a crustacean.

Since the life cycle and hosts, the exact locality where infection takes place, and the life span of the adult trematode are unknown, interpretation must be based on the observed distribution of the infected sockeye. As noted in the previous section, mature *Tubulovesicula* occurred in certain stocks returning to spawn in North America and in many of the high-seas samples from North American waters to 171°E. longitude. The parasite was not evident in any of the samples from 170°E. longitude to the Sea of Okhotsk. Furthermore, in high-seas samples in which *Tubulovesicula* occurred in the *Hemiurus* and/or *Dacnitis,* it never occurred in the same individual fish as either of these two parasites, which are considered indicative of Asiatic origin of sockeye. It was, however, recovered from some sockeye simultaneously infected with *Triaenophorus.* Also, the distribution of sockeye infected with *Tubulovesicula* is quite similar to that of sockeye infected with *Triaenophorus.* It thus appears that *Tubulovesicula* is associated with sockeye of North American origin.

Hemiurus levinseni. This is another marine trematode which, in the adult stage, lives in the stomach of sockeye and other fishes. Its life cycle is unknown, but is presumably similar to that postulated for *Tubulovesicula.* The intermediate hosts, particularly the molluscan host, of *Hemiurus* are, however, probably different than those of *Tubulovesicula.* As with *Tubulovesicula,* interpretations must be based on the geographical distribution of sockeye infected with this trematode. It appears to have two main centers of distribution. One is in western waters (presumably Asiatic) and the other is in southern North American localities, the parasite occurring more frequently and abundantly in sockeye from the former area.

In all high-seas areas, other than in the Gulf of Alaska, *Hemiurus* is believed to indicate Asiatic origin of the infected sockeye for the following reasons: the continuous distribution of the parasite in the North Pacific in samples from the Sea of Okhotsk to 175°E. longitude and its absence from 180° to 160°W. longitude; the presence of *Hemiurus* in samples from the Bering Sea from 165°E. to 170°W. longitude and its absence east of 170°W.; the irregular occurrence of *Hemiurus* in samples from the Bering Sea taken between 175°E. and 170°W. longitude and the lower incidence in samples from this area than in samples from west of 175°E. longitude; the almost complete absence of *Hemiurus* from North American coastal samples taken north and west of Petersburg, southeast Alaska (ca. 57°N., 133°W.); and the fact that *Hemiurus* never occurred in the same individual sockeye as *Tubulovesicula* or *Triaenophorus* (although it was found in the same sample) but did occur together with *Dacnitis* in the same fish.

The presence of *Hemiurus* in some sockeye caught in the Gulf of Alaska probably indicates a relationship of these to those from southern North American localities. If it reflected a relationship with sockeye of western Pacific areas we should expect to find sockeye between 180° and 160°W. longitude infected with this parasite which, in fact, has not been observed.

The rare occurrence of *Hemiurus* in the Kuskokwim River, western Alaska, in the 1956 samples, and in Bristol Bay, Alaska, in the 1955 samples, probably does not materially affect the general conclusions regarding the origin of *Hemiurus*-infected sockeye taken on the high seas, but it would seem to leave open the possibility that *Hemiurus* infected sockeye in the Bering Sea could be of western Alaskan origin. However, in 1957, when *Hemiurus* was found in the Bering Sea samples as far east as 170°W. longitude, sockeye samples from western Alaska were entirely free of *Hemiurus.* If any appreciable numbers of *Hemiurus*-infected sockeye from the Bering Sea in 1957 were of Alaskan origin it seems that *Hemiurus* should have appeared somewhere in the 1957 samples from western Alaska. Whether the rare occurrence of *Hemiurus* in western Alaskan sockeye is due to an indigenous low rate of infection or whether it is the result of migration of such sockeye into western waters,

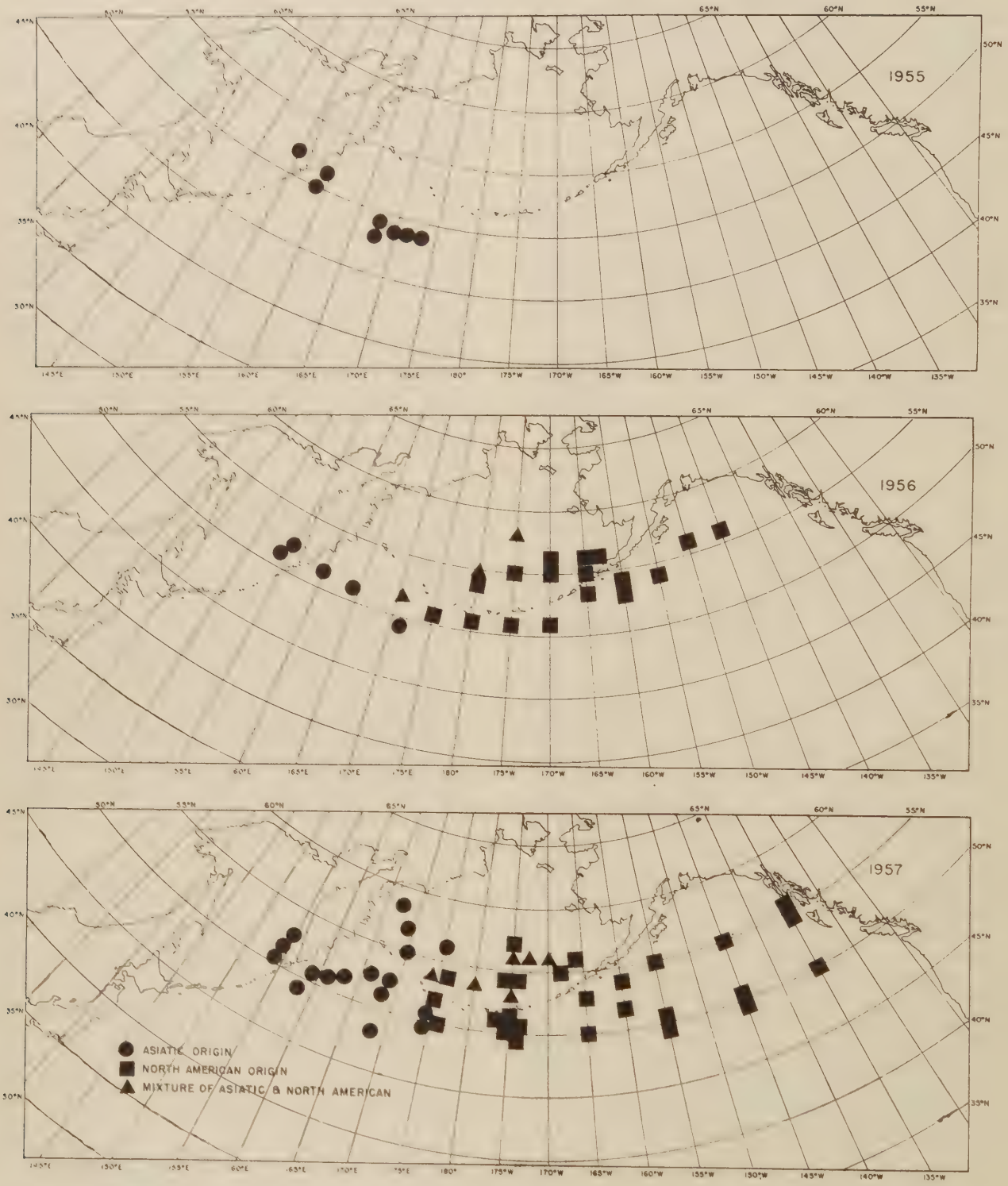


FIGURE 5. The distribution of sockeye salmon of Asiatic and North American origin, as determined by the presence of the parasites *Truenophorus*, *Tubulovesicula*, *Dacnitis* and *Hemiurus*, in high-seas samples collected from 1955 through 1957. (Note: Since in every sample only a portion of the fish possessed parasite characteristics enabling the identification of their continent of origin, these charts refer only to this portion of the samples.)

where *Hemiurus* is apparently readily available to sockeye, is not known.

iii. High-seas distribution of sockeye from North America and Asia as determined from the "indicator" species of parasites. Figure 5 shows the distribution of sockeye salmon of Asiatic and North American origin, as determined by the presence of *Triaenophorus, Tubulovesicula, Dacnitis* and *Hemiurus,* in high-seas samples collected from 1955 through 1957. On the basis of the distribution of these four parasites, the most western extent of North American sockeye was about 171°E. (in 1956) and the most eastern extent of Asiatic sockeye was at 170°W. (in 1957). Between 171°E. and 170°W. some samples showed only the presence of sockeye with North American parasite characteristics, others showed only sockeye with Asiatic characteristics, and some showed the presence of both. Because in all samples a greater or lesser number of individual sockeye do not possess any of the parasite characteristics which enable assignment of the fish to North American or Asiatic origin, it is possible that the range of distribution of stocks from the two continents is even greater than indicated.

The distribution of North American and Asiatic sockeye as suggested solely by the freshwater parasites *Triaenophorus* and *Dacnitis* limits the westward distribution of North American sockeye to 175°E. longitude and the eastward distribution of Asiatic sockeye to 175°W. longitude in the samples studied (see Fig. 4). The extension of this zone of overlap in high-seas distribution of sockeye from the two continents by inclusion of data on the distribution of the marine trematodes *Tubulovesicula* and *Hemiurus* probably has its explanation in the fact that the latter are more abundant and/or more widespread than the freshwater parasites in the stocks from either continent. For example, the incidence of *Hemiurus* is much higher than *Dacnitis* in Asiatic sockeye from the Sea of Okhotsk and off the east coast of Kamchatka. Therefore, when Asiatic stocks intermingle with North American stocks, and hence are "diluted", the probability of encountering *Dacnitis*-infected sockeye in a sample is less than the probability of finding *Hemiurus*-infected sockeye. The possibility that *Dacnitis* and *Hemiurus* do not occur together in all Asiatic stocks could also offer an explanation of the occurrence of only one or the other parasite in a sample of sockeye from the high seas. Again, *Tubulovesicula* is more widely distributed than *Triaenophorus* in samples from North American coastal localities and *Tubulovesicula* may indicate the high-seas distribution of some stocks not simultaneously infected with *Triaenophorus.*

Annual variations. Comparing the three years there appears to be some variation in the extent of distribution of sockeye from the two continents. In 1957 Asiatic sockeye were observed 5° farther east than in 1956 (170°W. compared to 175°W.), and in 1956 North American sockeye were observed 4° farther west than in 1957 (171°E. compared to 175°E.). In 1955 North American sockeye were not observed in the samples at 173°E.

Seasonal variations. In addition to the apparent annual variation, marked seasonal variations were noted at some sampling stations. South of the Aleutians, at 175°E. and 50° to 52°N., in samples collected early in June, 1957, there was no evidence of North American sockeye, but sockeye with Asiatic parasite characteristics were observed. In late August, at the same localities, no Asiatic sockeye were identified, but there was positive evidence of North American sockeye. Whether this same seasonal change in composition of samples occurs to the east or west of 175°E., south of the Aleutians, is unknown, since all samples from east of 175°E. were taken in mid or late summer, and all samples from west of 175°E. were taken in May or June.

Quantitative interpretation. Since only a portion of the fish in any one sample possessed parasite characteristics which enabled assignment to their continent of origin, it is impossible to determine the proportions of North American and Asian sockeye in the total sample from each locality. However, it is probably noteworthy, from a quantitative standpoint, that in the mixing zone, i.e. between 170°W. and 171°E., more sockeye with North American parasite characteristics than with Asiatic parasite characteristics were observed from 170° W. to 180°, but the reverse was true from 175°E. to 171°E.

B. Pink Salmon. The survey of pink salmon parasites has been in operation since 1955. The distribution and abundance of many of the parasites found in pink salmon were not uniform throughout the sampled areas and although differences in parasitism were observed between areas, these differences were not sufficiently stable from year to year to be useful in characterizing pink salmon stocks from the two continents. Studies on the parasites of pink salmon have been discontinued.

3. STUDY OF CHUM SALMON SCALES TO DISTINGUISH STOCKS

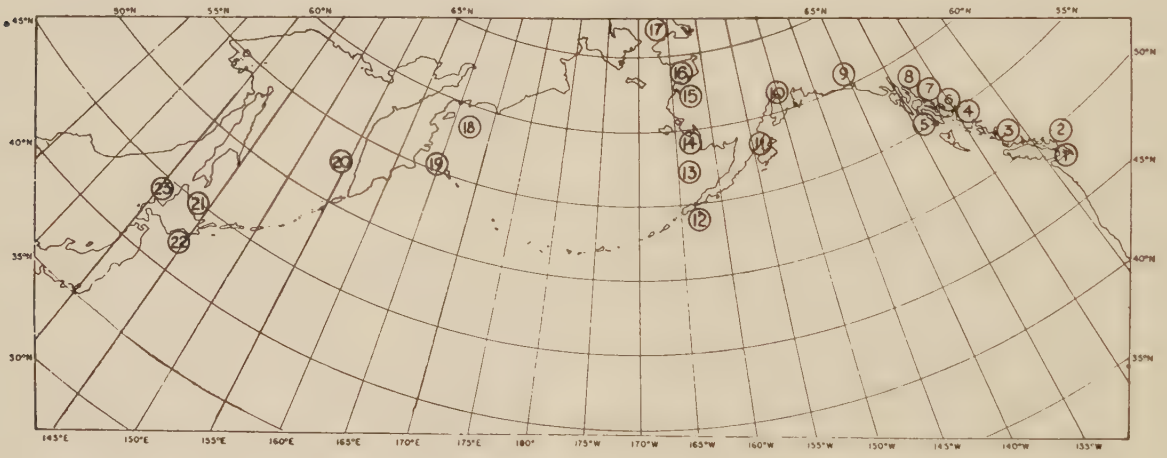
The Canadian study of chum salmon scales to distinguish stocks on the high seas was initiated in 1957. The scales of 3,751 adult chums collected in 1956 from various inshore fishing areas, spawning grounds and high-seas sampling stations were examined.

A. Examination of "Shore" Samples. Samples were obtained from mature chum salmon taken in 23 locations along the North American and Asian coasts. Where possible these samples were

taken in inshore fishing areas or river mouths immediately adjacent to the spawning grounds of the fish. Scale samples from 1,741 adult chum salmon from 6 river systems and 9 inlets on the North American coast and from 3 rivers and 3 high-seas fishing areas close to the Asian coast were examined. The comparative study was restricted to collections made in 1956. The sampling areas and the number of samples obtained from each area are shown in Figure 6.

Preliminary studies of these samples and of a series of samples taken on the Skeena River over a 3-year period (1955-1957) indicated (a) that the scale characters of the first-year zone were less subject to variations associated with the age, sex, and year of origin than were the patterns of the zones of the succeeding years; and (b) that the scale characters of the first-year zone showed a cline with respect to geographic location, whereas the patterns of the succeeding years showed a much less definite systematic trend. For these reasons the study was restricted to variations in first-year scale patterns.

Scales from chums of all ages and both sexes sampled in 1956 in different areas showed marked differences in the numbers of first-year circuli and in the spacing of these circuli. In general, the British Columbia chum salmon were characterized by having many closely packed circuli throughout the entire first-year band. Southeast Alaska fish also had densely packed circuli but the circuli were sparser in the first half of the band than in the second half. Central and western Alaska (including Bristol Bay) fish tended to have less densely packed circuli generally but these were more closely packed in the first half of the first-year band. Fish from the North Bering Sea, Arctic Ocean, and Northwestern Pacific Ocean (i.e. off the coast of Kamchatka and in the Sea of Okhotsk) tended to have sparse, well-separated circuli with no tendency for bunching either in the first or second half of the band. Scales of chum salmon from Japanese rivers were similar to those from Bristol Bay fish, but did not have circuli as closely compacted at the beginning of the first-year band. To illustrate differences in numbers and relative spacing of circuli, the numbers of circuli in the first and last halves of the first-year band and the total number of first-year circuli are illustrated in Figure 7. These figures were derived by pooling all samples within each of the 6 large areas.



Map No.	Location	Number of Samples
1	Puget Sound	68
2	Fraser River	100
3	Rivers Inlet	38
4	Skeena River	100
5	Davidson Inlet	62
6	Traitors Cove	100
7	Stikine River	100
8	Port Houghton	41
9	Taku River	95
10	Cook Inlet	90
11	Uyak Bay	100
12	King Cove	100
13	Bristol Bay	61
14	Kuskokwim River	17
15	Yukon River	59
16	Unalakleet River	93
17	Kotzebue Sound	100
18	Kamchatka Coast (55-56° N., 164-169° E.)	89
19	Kamchatka Coast (56-59° N., 166-169° E.)	49
20	Okhotsk Sea	77
21	Ubetsu River	96
22	Tokachi River	85
23	Ishikari River	21
	Total	1,741

FIGURE 6. "Shore" sampling locations for chum salmon utilized in 1956 scale studies.

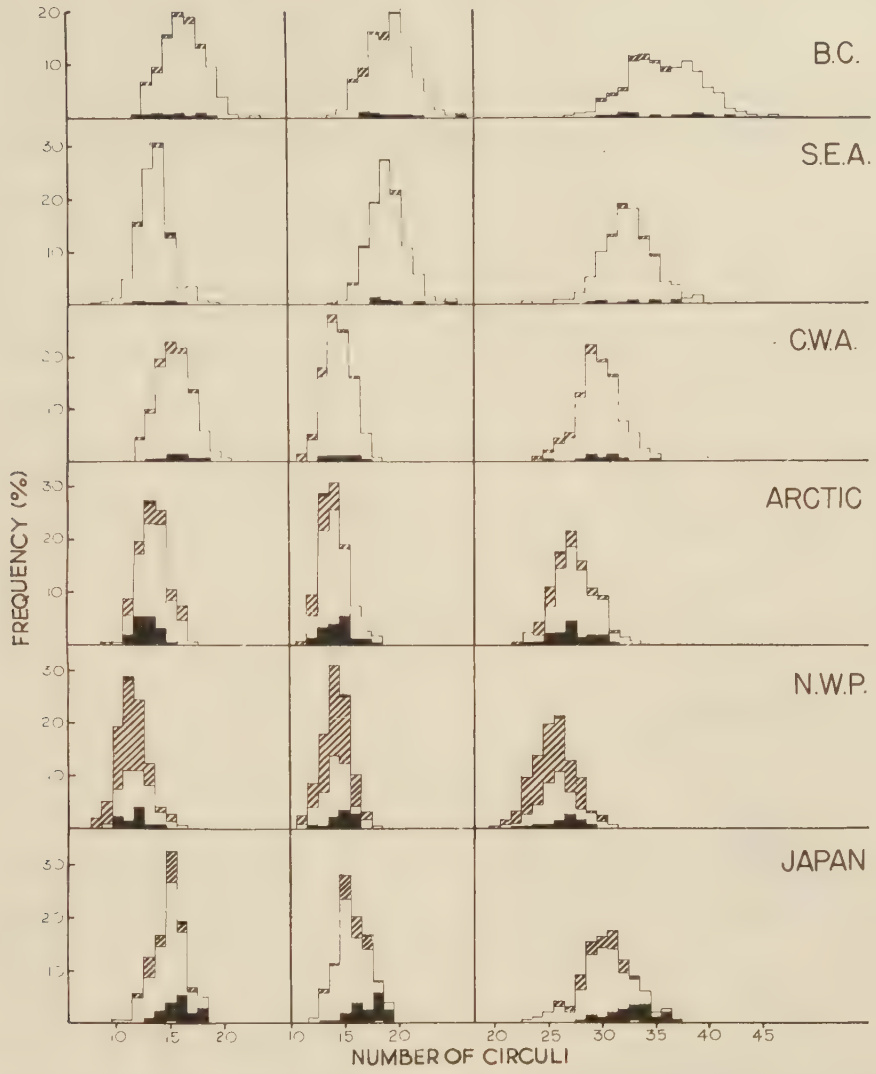


FIGURE 7. Distribution of first-year circulus counts for scales of chum salmon from different areas of the North Pacific.

Column A — Circuli in first half of first-year band.
Column B — Circuli in last half of first-year band.
Column C — Total first-year circuli.

Black bars indicate frequencies for 3_1 fish, white for 4_1's and cross-hatched for 5_1's.

While there were marked differences in the number of first-year circuli, there was relatively little difference in the width of the first annulus for fish originating in the different areas. The only group that tended to be divergent was that composed of fish sampled off the Siberian coast. The average width of the first annulus of these fish tended to be somewhat smaller than that for fish from the other 5 regions. (See Fig. 8).

B. Comparisons of Characters of High-seas Samples and "Shore" Samples. The scales of 2,010 chums taken on the high seas in 1956 were examined. For presentation of the data individual sampling stations have been grouped to provide 8 general areas, which are shown in Figure 9, along with the "shore" sample areas described in the previous section. In considering the high-seas data, differences in the time of sampling must be considered. The mid-Pacific samples (from Areas 5 and 6 in Fig. 9) were obtained early in the season (between May 30 and July 7). Samples in the Gulf of Alaska (from Areas 1, 2 and 3) and in the Western Pacific (from Areas 7 and 8) were obtained in

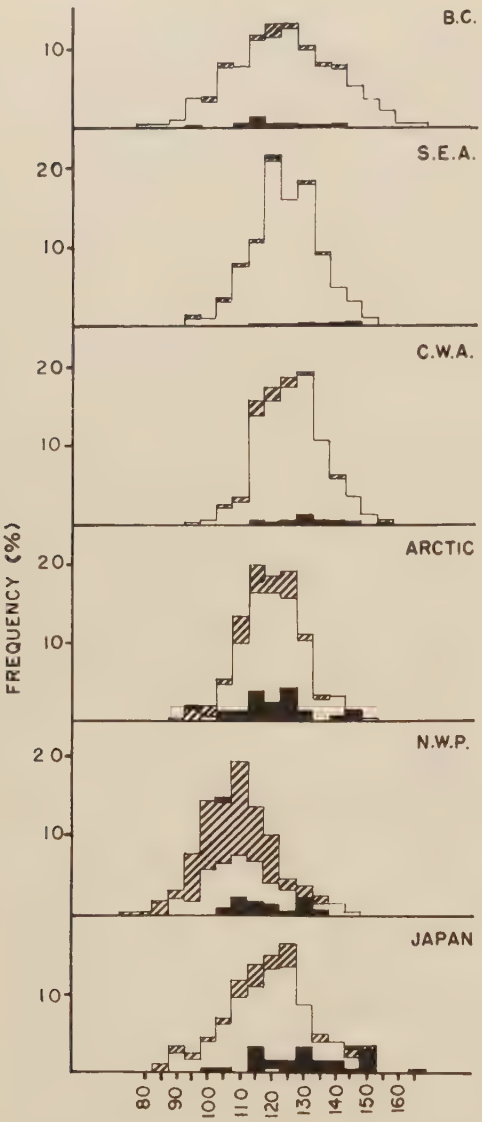


FIGURE 8. Width of first-year band in scales of chum salmon from different areas of the North Pacific.

mid-summer (July 2 to August 7). Samples from Area 4, between 160° and 170°W., south of the Aleutians were obtained later in the season (between August 18 and Septembr 13).

Numbers of circuli in whole and in last half of first-year zone. The number of circuli for the first year of life for fish from the 7 "shore" areas and 8 high-seas sampling areas are illustrated in Figure 9. Data for the "shore" samples are illustrated by the black histograms, those for the high-seas stations by the clear histograms.

The data indicate that circulus counts for fish taken from all high-seas stations westward from 175°W., in both the early and middle parts of the season were consistently low, averaging between 24.1 and 25.7. These values were similar to those for samples taken in the North Bering and in the Sea of Okhotsk close to the Kamchatka coast and were distinctly lower than averages for any "shore" sample on the North American side or for Japan (averages for North American "shore" samples ranged from 27.3 to 35.1, the Japanese samples averaged 30.4). Over half of the fish taken in western high-seas areas had circulus counts of 25 or less; only a few fish from spawning grounds in North America (excepting those of the "Arctic" area) and in Japan had circulus counts as low. These facts strongly suggest that the bulk of the fish taken in the area westward from 175°W. had not originated in the chum-producing areas of Alaska and B.C. nor in the rivers of Japan. Presumably, then, they had originated in the spawning streams of continental Asia, with the possibility that some might have come from northern Alaska. Data on the annulus widths presented later strengthen this view.

The average circulus counts for chums taken in the area eastward from 170°W. were consistently higher than those for fish taken in the western North Pacific area. The average first-year circulus counts for fish from the 4 high-seas areas eastward from 170°W. were quite similar to the average for fish from central and western Alaska. However, the frequency distributions of the circulus counts (Fig. 9) were characterized by wide ranges and flat domes suggesting that the samples were mixtures of fish of different origins.

Examination of the number of circuli in the last half of the first-year band provides more precise information on the probable origin of fish contributing to these mixed samples. As indicated in Figure 7, fish having 20 or more "last-half" circuli were found only among "shore" samples from the B.C.-southeast Alaska area. Last-half circulus counts for fish both from "shore" areas and from the 8 high-seas fishing areas are shown in Figure 10. In Table 8 the percentages of fish exhibiting counts of 20 and more from each area are listed. The results indicate that fish having last-half circulus counts of 20 or more, which were presumed to be B.C.-southeast Alaska fish, were restricted almost entirely to the area eastward from 170°W. Of the 1,392 fish from both high-seas and "shore" samples taken in areas westward from 175°W., only one had a count of 20 or over. Thus, B.C.-southeast Alaska fish failed to form a significant fraction of the early and mid-season samples of chums taken in the Western Pacific.

Within the Gulf of Alaska area, where the fish with high circulus counts contributed significantly to the catches, the greatest proportion (23.9%)

TABLE 8. Number of fish having circulus counts for the last half of the first year band of 20 or greater for chum salmon sampled in 1956 from 7 "shore" areas and 8 high-seas sampling areas.

Sampling area	No. fish sampled	No. fish with 20+ circuli	
		No.	%
British Columbia	306	151	49.3
Southeast Alaska	398	155	38.9
Area 1	142	34	23.9
Area 2	300	2	.6
Area 3	301	22	7.3
Central and western Alaska	368	0	0
Area 4	292	32	10.9
Arctic	252	0	0
Area 5	117	0	0
Area 6	365	1	.3
NW Pacific	138	0	0
Area 7	181	0	0
Area 8	312	0	0
Okhotsk Sea	77	0	0
Japan	202	0	0

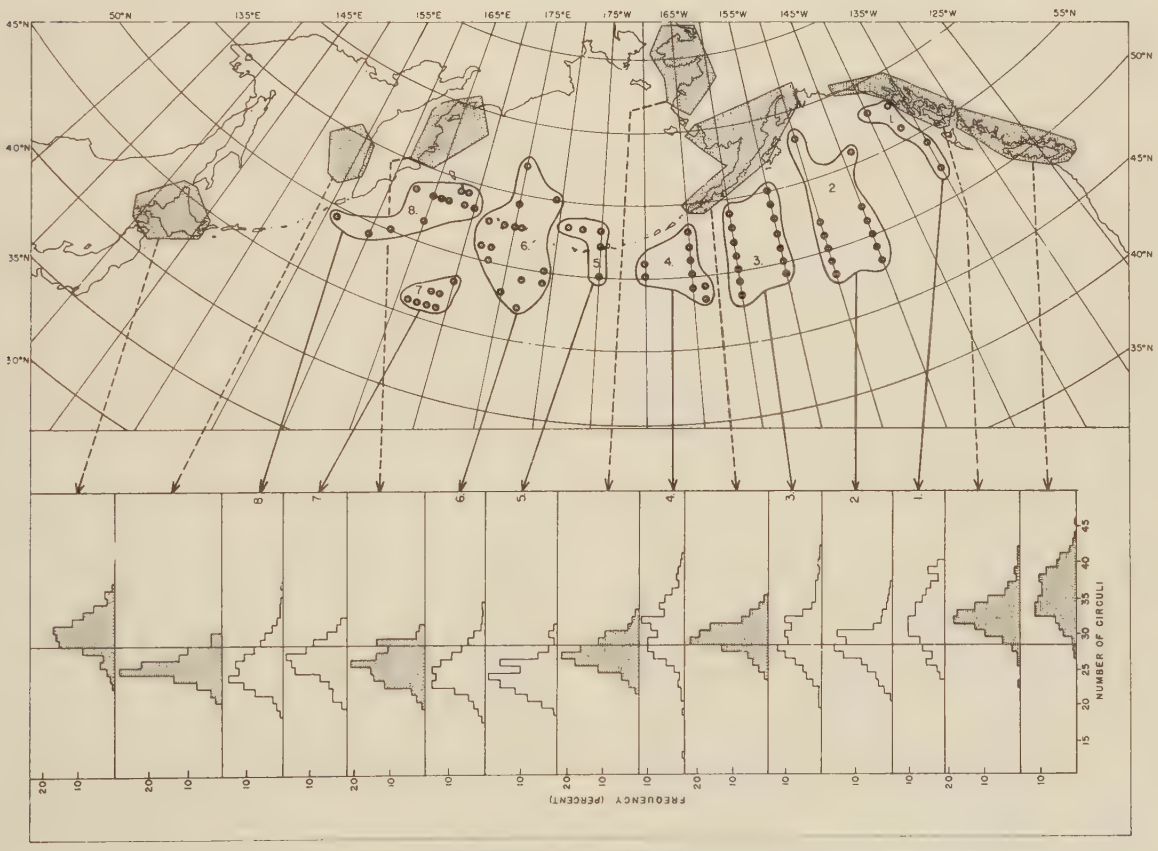


FIGURE 9. Total number of circuli in first-year band in scales of chum salmon from various areas in the North Pacific in 1956.

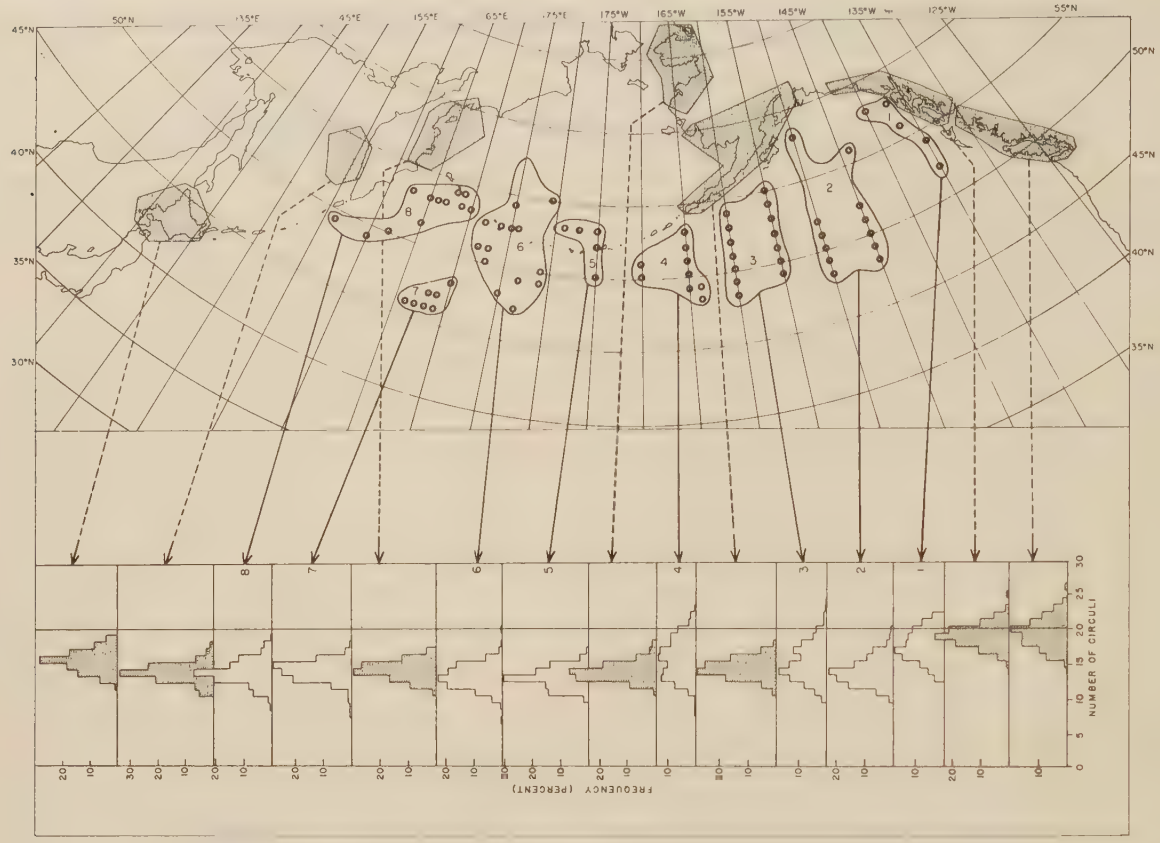


FIGURE 10. Number of circuli in the last half of the first-year band in scales of chum salmon from various areas in the North Pacific in 1956.

was found in the mid-season catches immediately offshore from the B.C.-southeast Alaska coast (Area 1). The mid-season and late-season samples from Areas 3 and 4 immediately south of the Alaska Peninsula also showed substantial numbers of high-count B.C.-southeast Alaska fish (7.3 and 10.9% respectively). However, the mid-summer sample from the central Gulf of Alaska (Area 2) contained only a small fraction of fish of the B.C.-southeast Alaska type (0.6%).

Width and number of circuli in first-year zone. Chum scales from the "shore" areas of the west Bering Sea and from the Sea of Okhotsk had few first-year circuli and narrow first-year zones. Table 9 shows the percentages of fish from each of 7 "shore" areas and 8 high-seas areas having first-year circulus counts of less than 24 *and* first-year zone widths of 1.15 mm. or less. Among the "shore" samples, those from the Kamchatka coast on the Bering Sea side contained the greatest number of these fish with low circulus count and low zone widths (averaging 25.4%). The Sea of Okhotsk samples had 11.7%, the Arctic Sea had just 2.0%, while all other "shore" areas had fewer than 1% of this type of fish.

Examination of the characteristics of the 1956 high-seas samples indicates that in the region westward from 175°W. (Areas 5 - 8), all samples contained substantial proportions of fish with first-year circulus counts of 24 or less and first-year zone widths of 1.15 mm. or less. In this region, between 15.5% and 48.7% of the fish sampled exhibited the low counts and small widths. Considering the fact that no "shore" area in North America exhibited samples with more than 2% of fish of this type, the great majority of fish in the area westward from 175°W. were most probably fish of continental Asiatic origin. Fish from Areas 5 and 6 in the central North Pacific Ocean and central Bering Sea had even higher proportions of "low count-small width" fish than did the "shore" samples used to characterize continental Asiatic stocks. One explanation for this might be that the so-called "shore" samples from the western region were not truly representative of chum stocks originating in Asian streams; it is possible that Asiatic populations exist which contain even higher proportions of "low count-small width" fish than those represented in the type samples taken off the Kamchatka coast.

TABLE 9. Numbers of chum salmon with first-year circulus counts of less than 24 and first-year zone widths of 1.15 mm. or less in samples from 7 "shore" areas and 8 high-seas areas in 1956.

Sampling area	No. fish sampled	No. fish with 24 - circuli 1.15 - annulus width	
		No.	%
British Columbia	306	--	--
Southeast Alaska	398	1	.2
Area 1	142	2	1.4
Area 2	300	21	7.0
Area 3	301	13	4.3
Central and western Alaska	368	1	.3
Area 4	292	10	3.4
Arctic	252	5	2.0
Area 5	117	57	48.7
Area 6	365	136	37.3
NW Pacific	138	35	25.4
Area 7	181	28	15.5
Area 8	312	89	28.5
Okhotsk Sea	77	9	11.7
Japan	202	1	.5

In the samples taken from the areas eastward from 170°W. (Areas 1 - 4), the proportion of "low count-small width" fish was higher than for the "shore" samples taken on the adjacent spawning streams. This was especially true for the mid-summer samples from the center of the Gulf of Alaska (Area 2) where 7% of the fish sampled possessed very low circulus counts and annulus widths. It is tentatively concluded that at least some of the fish caught in this area were of continental Asiatic origin.

Discussion. In interpreting the foregoing data, a number of limitations must be borne in mind. First, the "shore" samples used to characterize fish originating in continental Asia were actually composed of fish taken in offshore fishing and may well have included fish bound for other areas. Samples of fish from the large chum-producing rivers of the U.S.S.R. are still required to provide a sound assessment of the continental origin of fish in the high-seas catches. Second, the present study must be extended to include data for other years. In examining the 1956 data, the "shore" samples for fish from North American and Japanese rivers were composed mainly of 4-year-olds while 5-year-olds predominated in the Northwest Pacific and Okhotsk samples. However, the high-seas samples studied contained substantial numbers of 2- and 3-year-olds. For this reason, data for "shore" samples in succeeding years would be desirable for a more accurate interpretation of the results. Third, in the present analysis, there were not enough samples available from the important area in the vicinity of 175°W. It is hoped that as scales from collections of whole fish become available this shortcoming will be remedied.

Despite these deficiencies, this preliminary study did reveal marked differences in the characteristics of scales from chum salmon taken in various parts of the North Pacific. The following tentative conclusions are reached:

(1) The area westward from 175°W. On the basis of first-year circulus counts and measurements of annulus widths, high-seas samples of chum salmon taken in the area westward from 175°W. in 1956 did not appear to contain an appreciable proportion of fish originating in North American streams south of the 62°N. parallel. Fish of the type found in Japanese streams apparently did not form a substantial fraction of the total population sampled in this area. Similarities in the types of scales found on fish from the northernmost part of Alaska and from fish taken close to Kamchatka indicate that some fish in the western half of the North Pacific might have originated in the northernmost chum streams of North America. It is concluded, however, that the majority of chums taken on the high seas westward from 175°W. originated in Asiatic streams outside of Japan.

(2) The area eastward from 170°W. High-seas samples examined from the area eastward from 170°W. were restricted mainly to the region south of the Aleutians and in the Gulf of Alaska. These samples contained fish which could be identified positively as originating in the streams of B.C. or southeast Alaska and a minor fraction which could be ascribed to fish originating in continental Asia. The remainder, which formed the bulk of the samples, were fish with intermediate scale characteristics which could, in theory, have originated in the central area of Alaska or in Japan.

In view of the proximity of the sampling areas to the important spawning grounds of Alaska and of the lack of substantial proportions of fish of the Japanese "shore" sample type in the high-seas catches of the central Pacific, it is concluded that most of the unclassified fish were North American in origin.

4. OCEANOGRAPHY

Since the last summary report (1957) three surveys have been completed. The first, essentially a winter survey, was from March 11 to April 10. The second, a summer survey, was from July 22 to August 16. These covered the Gulf of Alaska and adjacent ocean. The third survey was carried out between June 27 and August 14, during which time one month (July 5 to August 5) was spent in the vicinity of the Aleutian Islands. Observations were also made enroute to and from this area and have been incorporated with those in the eastern Pacific. Observations at ocean weather station "P" (latitude 50°N., longitude 145°W.) have continued regularly, through alternate six-week periods.

These data have been published. They have been supplemented by data from the Department of Oceanography, University of Washington, Seattle, and the United States and Canadian exploratory fishing vessels. Some of the important oceanographic features noted in these data are briefly summarized.

March, 1958 — Gulf of Alaska

Salinity. The horizontal distribution of salinity at 10 meters is shown in Figure 11. The configuration of the isohalines is generally the same

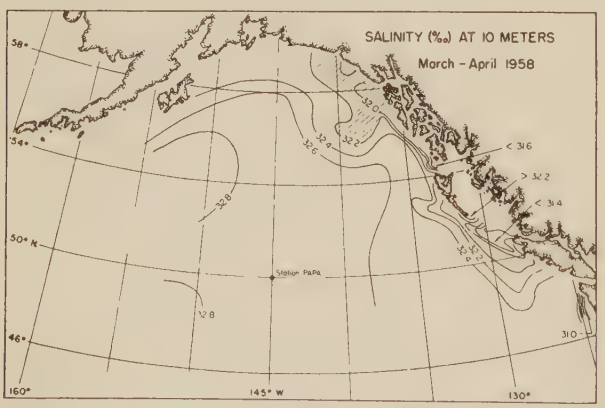


FIGURE 11. Salinity at 10 meters depth in the eastern North Pacific in March-April, 1958.

as for the previous summer. There was a salinity maximum (>32.8°/₀₀) in the Gulf of Alaska, which is associated with the anti-clockwise circulation around this centre. Northward and eastward of the centre the salinity decreased. Southward the salinity decreased then increased, similar to former periods. One feature that differs from the previous period was the extension of low salinity water (<32.2°/₀₀) offshore off the eastern side of the Gulf of Alaska.

The salinity distribution at 100 meters depth (Fig. 12) is generally representative of the distribution of fresh water in the upper zone—i.e. low salinity values indicate a large accumulation of

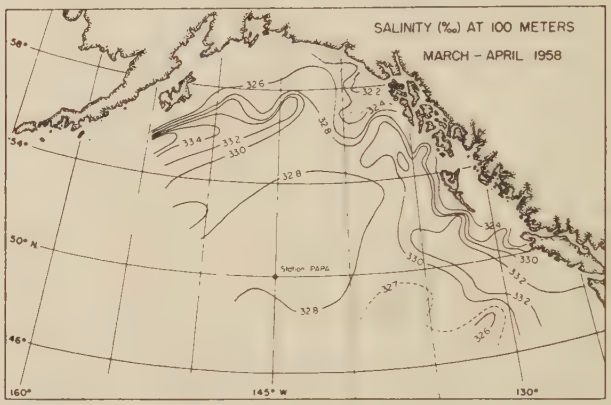


FIGURE 12. Salinity at 100 meters depth in the eastern North Pacific in March-April, 1958.

fresh water in the upper zone. Again the configuration of the isohalines is generally similar to the previous summer, and somewhat similar to the previous winter. However, in the eastern Gulf of Alaska, there was an area of low salinity water (<32.4°/₀₀). This indicates a much larger accumulation of fresh water in this area than in previous periods.

The evident cell of relatively low salinity (<32.7°/₀₀), between longitudes 130° and 140°W., off the Washington-Vancouver Island coast, present in previous surveys, is also indicated.

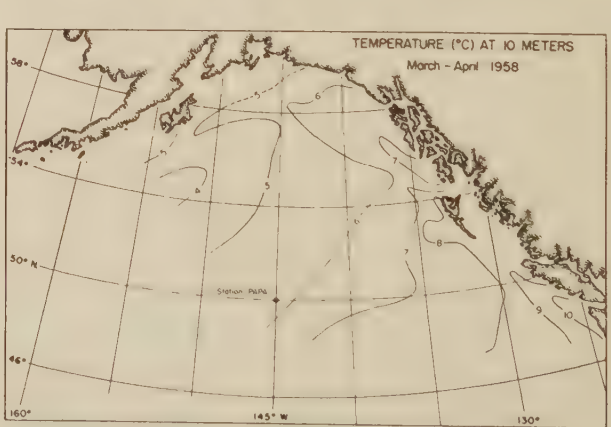


FIGURE 13. Temperature at 10 meters depth in the eastern North Pacific in March-April, 1958.

Temperature. As in the previous winter the cold centre (<4°C.) in the Gulf of Alaska (Fig. 13) corresponded in position with the centre of high salinity. Compared to the previous winter there was a more northward slant of the isotherms between ocean weather station "P" and the coast. Also the 4°C. isotherm enclosed a smaller area than in the previous winter. Thus, over the whole area, surface temperatures were about 1 to 2 degrees warmer than during the previous winter.

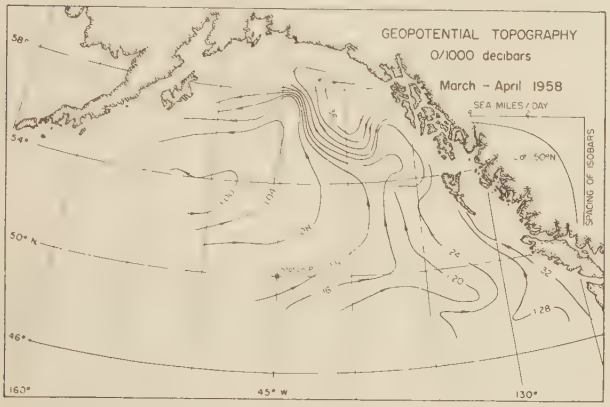


FIGURE 14. Geopotential topography in the eastern North Pacific in March-April, 1958.

Calculated currents. Figure 14 shows the geostrophic flow for this period. The general features of the circulation persisted. There are two marked differences from the previous summer. The flow was more northerly in the mid-Gulf area during this period than previously. This suggests intrusion of southern-type water into the area and would account for the high surface temperatures off the Canadian coast. Secondly, associated with the low salinity centre in the eastern Gulf of Alaska, there was a clockwise gyral.

August, 1958 — Gulf of Alaska

Salinity. As shown in Figure 15, the salinity at a depth of 10 meters was least in the shallow water over the continental shelf and increased seaward. The low salinity water appears to extend farther offshore than previously, especially in the northern part of the Gulf of Alaska. Also the high salinity centre in the Alaska Gyral was not evident.

The salinity distribution at 100 meters depth is presented in Figure 16. Relatively high values were observed along the west coast of Vancouver Island and in the vicinity of the Alaska Gyral. These are typical, although in the former region the values are perhaps higher than usual. An interesting feature of the figure is the indication of clouds of low salinity water (<32.7°/00) (shaded) lying well seaward off the mainland coast.

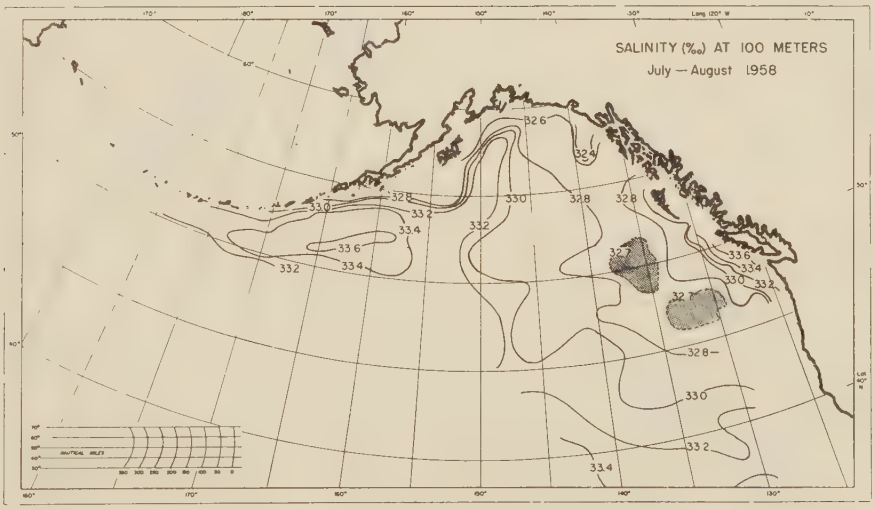


FIGURE 15. Salinity at 10 meters depth in the eastern North Pacific in July-August, 1958.

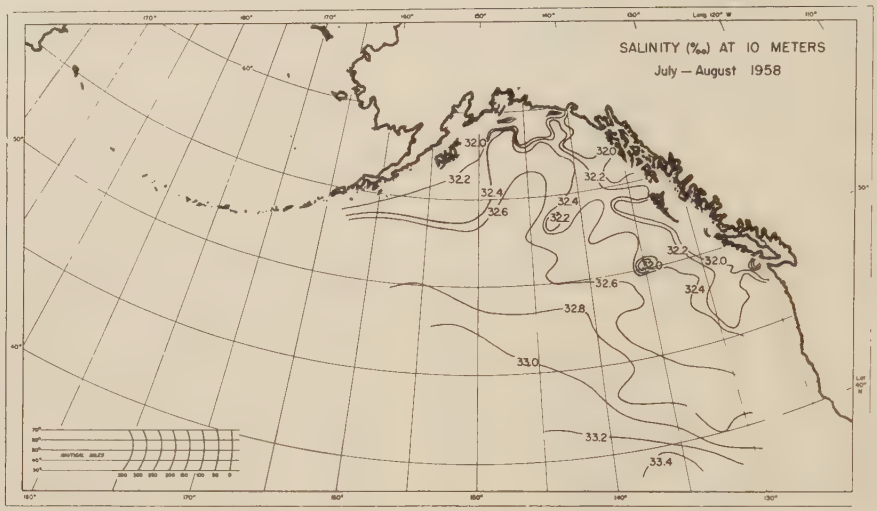


FIGURE 16. Salinity at 100 meters depth in the eastern North Pacific in July-August, 1958.

Temperature. The observed distribution of temperature at 10 meters depth is shown in Figure 17. A comparison with earlier reports suggests that in the oceanic region eastward of the longitude of station "P" the temperatures were not only above average, but also above those observed in the summer of 1957.

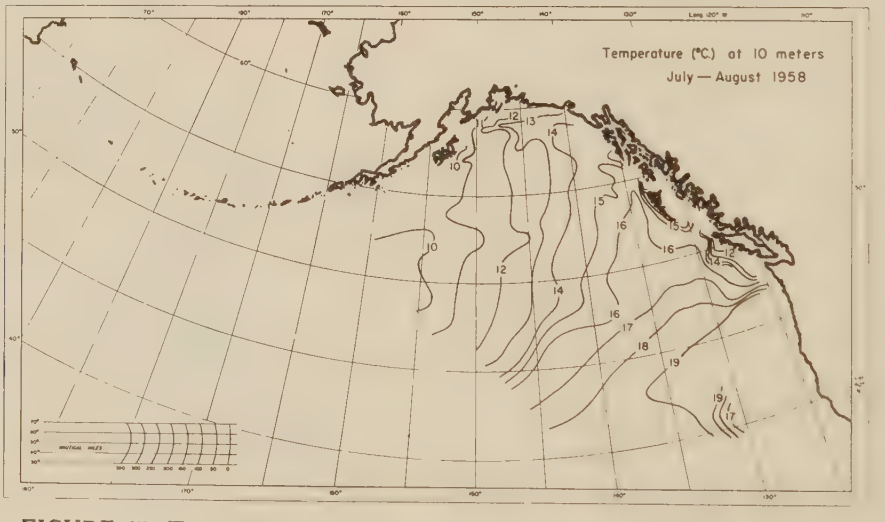


FIGURE 17. Temperature at 10 meters depth in the eastern North Pacific in July-August, 1958.

Calculated currents. The geopotential topography referred to the 1,000 decibar surface is shown in Figure 18. The general configuration of the isobars suggests the existence of a somewhat different situation from that observed in the previous surveys. The isobars in mid-ocean exhibit a stronger than usual north-south tendency, and in addition, there is evidence of a southerly movement in the water adjacent to the Canadian coast. This latter feature is perhaps the most interesting since it represents a marked departure from what is considered the usual. It was, however, observed in August, 1936.

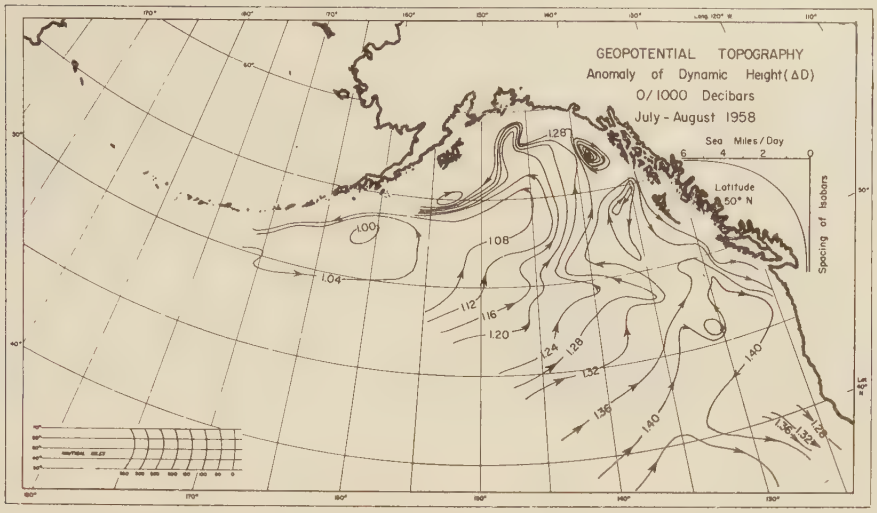


FIGURE 18. Geopotential topography in the eastern North Pacific in July-August, 1958.

General Summary of Conditions in the Gulf of Alaska. Between Station "P" and the coast the movement of water has veered progressively northward since 1955. Associated with this there has been a progressive increase in the temperature of the surface waters in this region from summer to summer and winter to winter.

Further analysis shows that this increase was not solely a result of seasonal heating and cooling and thus limited to the depth of seasonal influence (125 meters). That the warming extended into the non-seasonal waters can be shown by considering the temperature distribution on the surface at which the density is 1.0266 ("sigma-t"=26.60). Figure 19 shows that the depth of this surface was generally greater than 175 meters in the area off the Canadian coast and therefore below the depth of seasonal influence. Figure 20 shows the distribution of temperature on this surface for the 6 periods since 1955. In this analysis it is assumed that the flow in general is parallel to the isotherms, which is confirmed by the calculated currents. Thus the changes in circulation of the intermediate water from the summer of 1955 to 1958 are reflected in these figures. They show that there was a progressive northward intrusion, off the Canadian coast, of warm water, arbitrarily indicated by the water of temperature 6.5°C. or greater (shaded areas). The intrusion reached a maximum in March, 1958, and persisted until at least August, 1958. This suggests that the northerly offshore flow postulated from the summer data of 1957 was intensified during the winter period, hence

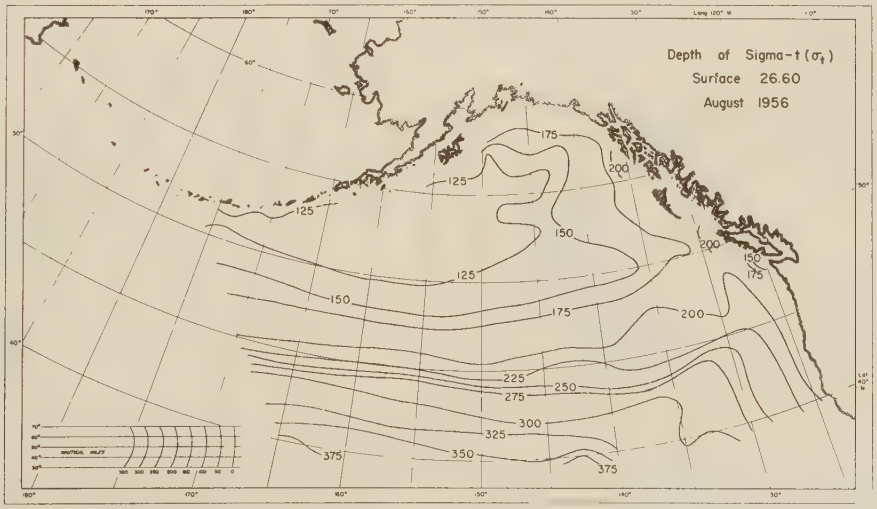


FIGURE 19. Depth of the surface at which the density is 1.0266.

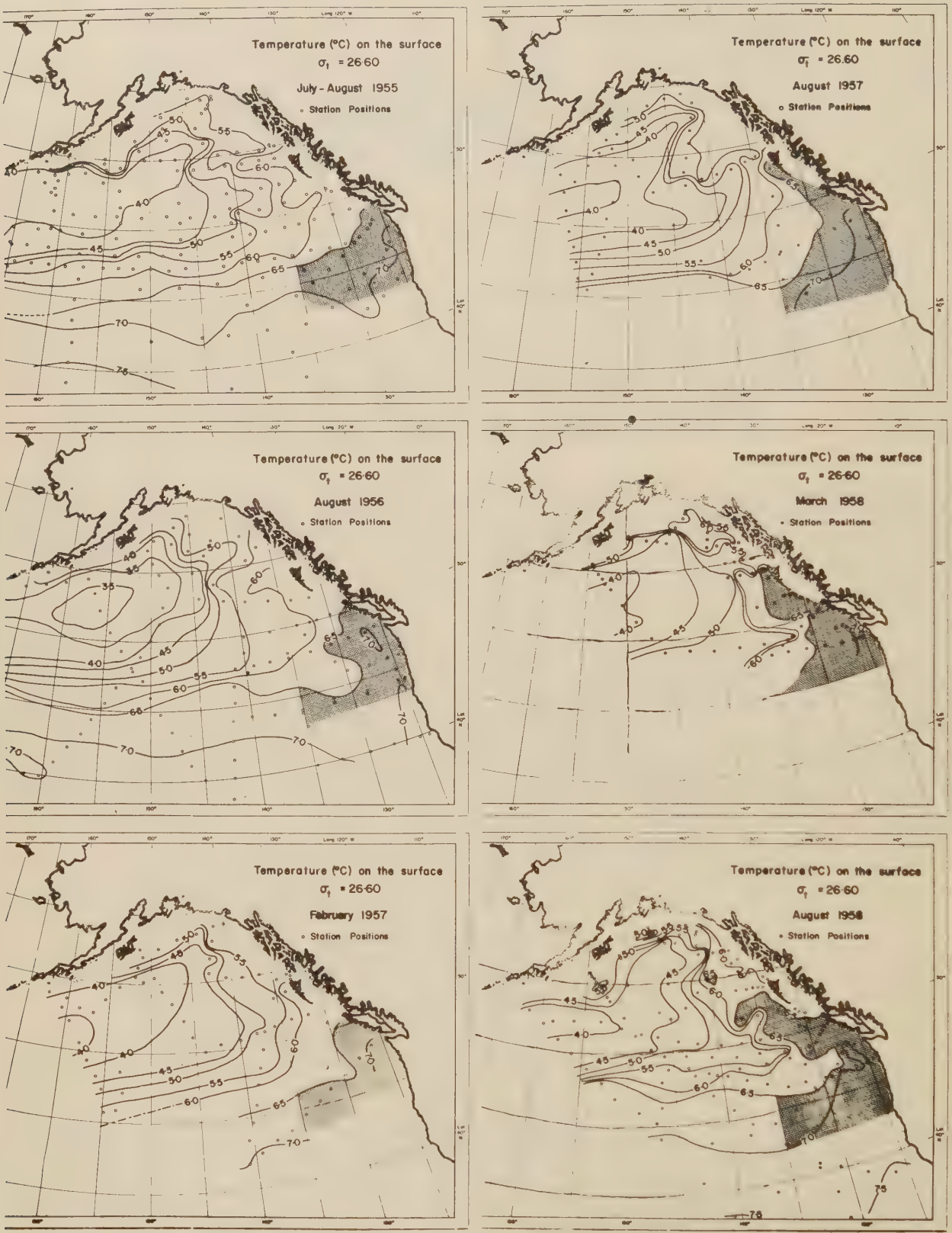


FIGURE 20. Temperatures on the surface of density 1.0266.

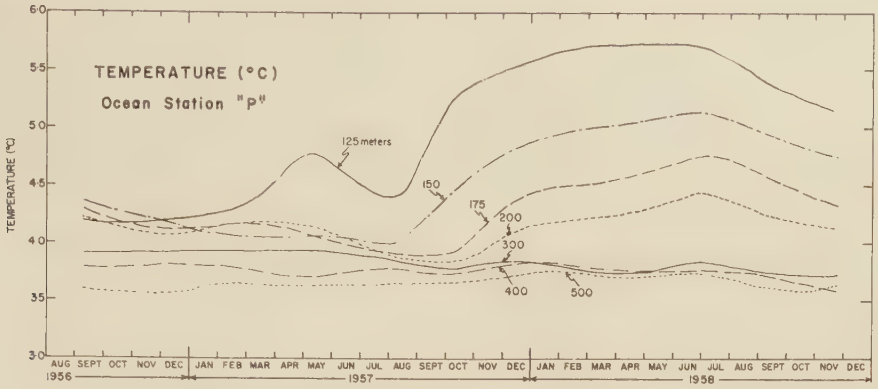


FIGURE 21. Temperature structure at Station "P"

making it possible for warm water from the south to flow into this region.

The warm water intrusion between Station "P" and the coast is reflected in the temperature structure at Station "P" down to a depth of 500 meters (Fig. 21). These data show that the warm water intrusion had intensified since August, 1957, and was at a maximum in July, 1958, at Station "P". More recent data suggests that the warm water intrusion is relaxing at Station "P". Thus it is possible that oceanographic conditions off the Canadian coast and extending to Station "P" may be similar to those observed in August, 1957, within the next two or three months. The winter survey in 1959 should confirm or disprove this.

Oceanographic Observations in the Aleutian Area, July-August, 1958. Figures 22 and 23 show the vertical distribution of temperature and salinity along 179°30′E. longitude. North and south of the Aleutian Islands there was a well-defined thermocline extending to about 60 meters depth. Within this layer higher salinity and slightly lower temperatures occurred in the Bering Sea than in the region south of the Islands. The temperature then decreased to a sub-surface minimum (dichothermal water); then increased to a maximum (mesothermal water). Associated with the mesothermal water, the salinity structure showed a halocline, or a gradient of increasing salinity sufficient to make the structure stable. Below this layer, the temperature gradually decreased and salinity increased with depth.

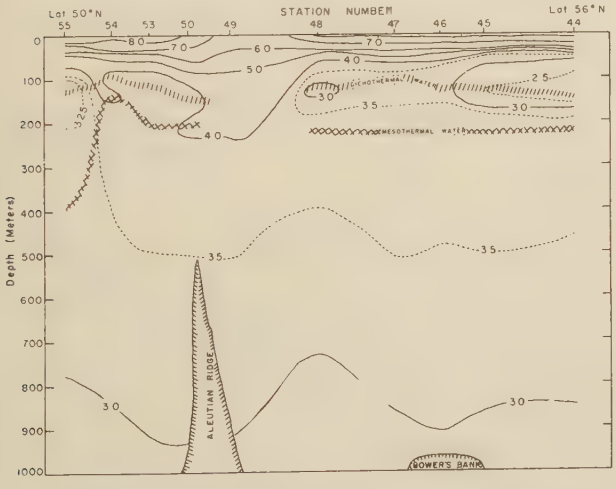


FIGURE 22. Temperature section along 179°30′E. Longitude, July 20-23, 1958

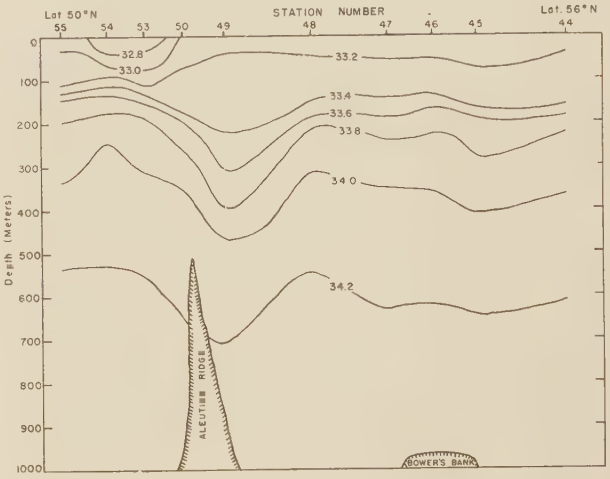


FIGURE 23. Salinity section along 179°30′E. Longitude, July 20-23, 1958.

The depth and temperature of the mesothermal water were fairly constant in the Bering Sea, except in the eastern part (Fig. 24). This was especially true in this section, in which its depth was approximately 220 meters and the temperature varied by only 0.17 degrees. South of the Islands both the depth and temperature of this water varied. This is noted particularly at Station 55 (Fig. 22), the southern limit of this section. At this station, the depth of the mesothermal water was about 400 meters, and the temperature was 3.4°C., approximately 200 meters deeper and 0.7 degrees

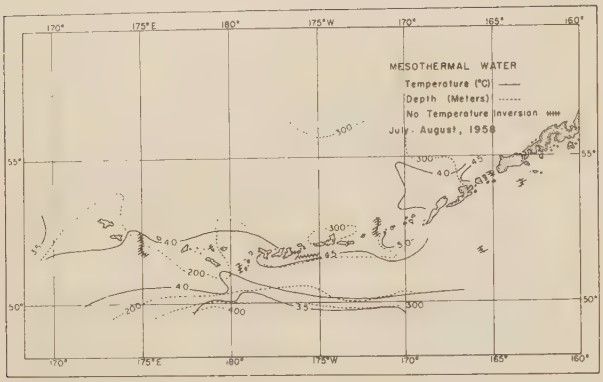


FIGURE 24. Temperature and depth of the mesothermal water in July-August, 1958.

colder than the water to the north. This suggests a marked discontinuity between Stations 54 and 55; a colder and less saline water mass in the depth interval 100 to 400 meters to the south than to the north. This feature is worthy of closer examination.

The temperature and depth distributions of the mesothermal water are shown in Figure 24. South of the Islands relatively warm water (>4.0° C.) extended westward to at least 170°E. longitude and intruded into the Bering Sea between longitudes 177°W. and 174°E. Similar warm water also appeared in the southeastern part of the Bering Sea. Over the remainder of the area, north of the Islands, the temperature of the mesothermal water was fairly constant and less than 4.0 degrees.

It is probable that the cold water mass (<3.5° C.) described at Station 55, extended eastward to the vicinity of longitude 170°W.

The temperature and depth distribution of the dichothermal water are shown in Figure 25. The depth of the water generally varied between 100 and 150 meters and was found at greater depths in the Bering Sea than south of the Islands.

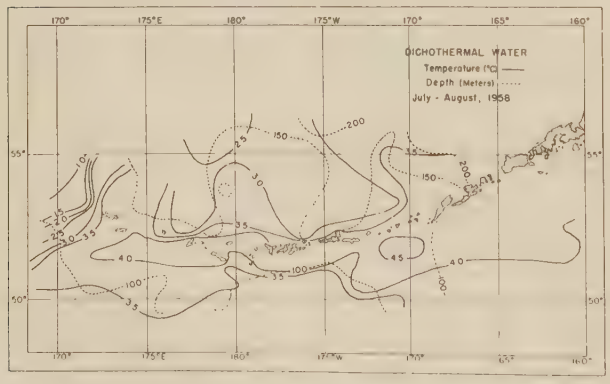


FIGURE 25. Temperature and depth of the dichothermal water in July-August, 1958.

South of the Islands the dichothermal water was relatively warm (>4.0° C.). This water showed much the same distribution as the warm mesothermal water with an intrusion into the Bering Sea. At the western and north-western limits of the survey, low temperatures were common (<2.5° C.). In the western area there was a marked gradient extending to the western tip of Attu. This suggests an area of convergence, probably having a seasonal and yearly shift. Northward of the Islands the temperature of the dichothermal water was generally less than 3.5 degrees.

A comparison of the temperatures of the mesothermal and dichothermal waters shows that generally in the Bering Sea there were marked differences in the temperatures of these waters. However, south of the Islands, the differences were small. In fact there were areas where no mesothermal water occurred.

Figures 26 and 27 show the distribution of temperature and salinity at 10 meters depth. North of the Aleutian Islands salinity was higher and temperatures were slightly lower than those south

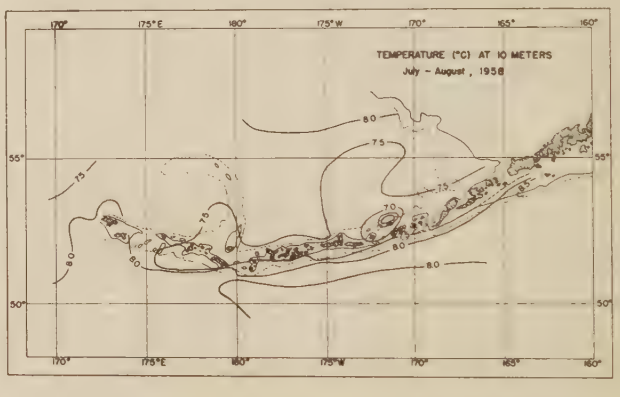


FIGURE 26. Temperature at 10 meters depth in July-August, 1958.

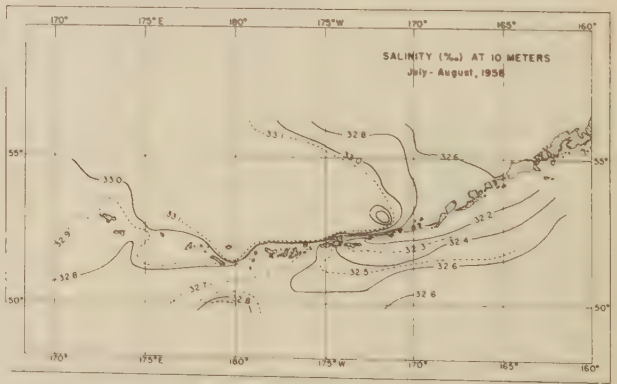


FIGURE 27. Salinity at 10 meters depth in July-August, 1958.

of the Islands. In the near vicinity of the Aleutian Islands there was generally a marked gradient. This is particularly noted in the salinity distribution (Fig. 27) westward to longitude 175°W.

The calculated currents are shown in Figure 28. Close along the southern side of the Aleutian

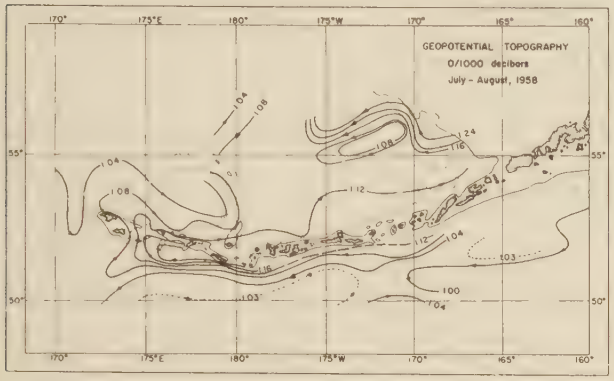


FIGURE 28. Geopotential topography in July-August, 1958.

Islands there was a relatively strong westerly flow, originating from the Gulf of Alaska, extending as far west as 173°E. longitude. There was a marked intrusion into the Bering Sea east of Attu, and then an easterly return flow close along the north side of the Aleutian Islands. The main flow in the Bering Sea seemed to conform to the bottom topography. In the western part, the flow followed around on the west side of Bowers Bank. The remainder of the flow continued eastward to the Continental Shelf where it again was deflected northward and then westward, probably by the configuration of the bottom topography.

South of the Aleutian Islands, in the vicinity of the cold mesothermal water (Fig. 24), it is suggested that the flow from the west approaches the Islands and results in an anti-clockwise circulation. This results in an interchange of water between these two streams.

Although not evident in this picture, there was a marked surface flow through the channels. In most cases this water lost its structure due to extreme mixing.

B. REPORT OF RESEARCH ON SALMON CONDUCTED BY JAPAN IN 1958 FOR THE INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Fisheries Agency of Japan

INTRODUCTION

The program of coordinated research on salmon by the three countries in the North Pacific, which commenced in 1955, is approaching the end of its fourth year. Catch records and measurement data obtained by government research vessels and from the commercial fisheries have been accumulated and extensive research materials have been obtained, through exchange of samples and data under the coordinated program, from almost the entire range of salmon distribution in the North Pacific. Accordingly, progress was noted in every field of research in 1958. It is hoped that further efforts will be made toward research coordination between the three countries.

Since 1957, Japanese research has been conducted principally by the Hokkaido Regional Fisheries Research Laboratory, in co-operation with the Hokkaido Salmon Hatchery, Hokkaido University and the Fisheries Department of the Tokyo University.

In 1958, one of the two government research vessels was engaged in the collection of salmon samples in the waters off the Olyutorski district; an area which had not been investigated. The results of the analysis of these samples are not yet available, but it is believed that valuable information will be forthcoming.

During 1958, some phases of Japanese research reached a stage which allows summarizing of their results.

1. OFFSHORE DISTRIBUTION OF SALMON

A. Collection and Analysis of Records of Commercial Catches

Catch statistics for the mothership salmon fishery in Aleutian waters in 1958 are given in Tables 1 and 2.

B. Special Fishing by Research Vessels for Scientific Material

The following two vessels were chartered by the government as research vessels for this purpose:

Kano-maru: Steel Vessel; 152 gross tons; 330 h.p.

Wakashio-maru: Steel Vessel; 153 gross tons; 320 h.p.

The *Wakashio-maru* fished the waters of the Aleutian Islands on both sides of the provisional line (175°W.) during May and the waters in the Bering Sea on both sides of the provisional line in June to study the relative abundance of salmon in these waters and to collect samples for racial studies. The *Kano-maru* occupied the waters off the east coast of the Kamchatka Peninsula south of Cape Kamchatka from May to early June for the purpose of obtaining samples and data from the sockeye salmon going to the Kamchatka River. After that, she fished Olyutorski waters until the end of June in order to obtain samples and data from the salmon migrating to the streams of the Olyutorski coast. Both vessels came back to Kushiro for a short period of time in early and mid-July, before starting their second cruises. In their second cruises, both vessels fished the waters north

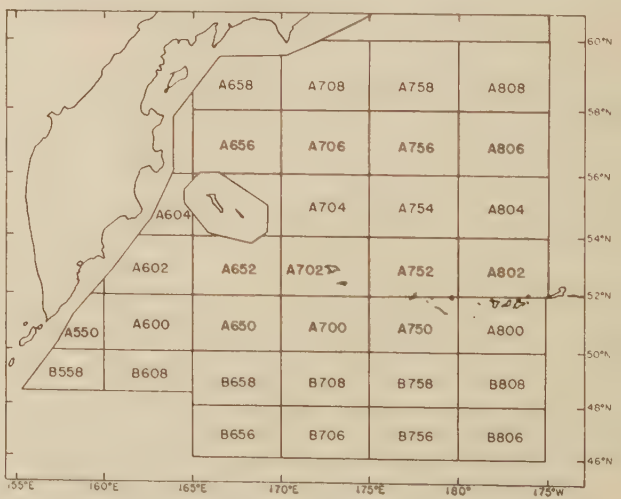


FIGURE 1. Statistical areas used in Table 2.

Table 1. Catch of the Japanese mothership salmon fishery in Aleutian waters by week and by species, 1958.

Week	Sockeye		Chum		Pink		Coho		Chinook		Total	
	No. of fish	Weight	No. of fish	Weight	No. of fish	Weight	No. of fish	Weight	No. of fish	Weight	No. of fish	Weight
		Kg.		Kg.		Kg.		Kg.		Kg.		Kg.
May 11-17	575,001	1,129,956	610,554	1,158,803	4,725	5,672	2	4	200	950	1,190,482	2,295,385
May 18-24	1,057,249	2,155,699	1,149,793	2,279,270	14,481	18,477	..	..	531	2,478	2,222,054	4,455,924
May 25-31	906,378	1,804,344	1,362,732	2,617,086	49,855	64,654	2	3	770	3,999	2,319,737	4,490,086
June 1- 7	924,096	1,883,006	1,358,032	2,624,309	251,985	329,908	18	33	1,676	6,945	2,535,807	4,844,201
June 8-14	1,355,204	2,672,688	1,607,623	2,927,799	646,603	837,099	311	561	2,940	11,266	3,612,681	6,449,413
June 15-21	795,469	1,543,348	1,772,388	3,269,173	1,958,077	2,456,110	445	852	3,377	12,071	4,529,756	7,281,554
June 22-28	1,605,942	3,162,847	1,034,732	1,861,581	525,334	678,411	3,092	5,875	2,633	9,026	3,171,733	5,717,740
June 29-July 5	848,007	1,708,228	1,084,203	2,120,872	1,235,152	1,692,589	4,926	10,387	2,320	7,285	3,174,608	5,539,361
July 6-12	864,251	1,718,940	2,091,303	4,084,088	2,799,805	4,036,814	53,227	117,786	3,603	11,149	5,812,189	9,968,777
July 13-19	733,337	1,465,550	1,236,072	2,298,264	3,335,225	4,972,296	315,044	739,027	4,027	12,133	5,623,705	9,487,270
July 20-26	854,374	1,831,668	741,800	1,380,709	1,003,138	1,523,830	481,696	1,177,511	3,294	10,200	3,084,302	5,923,918
July 27-Aug. 2	659,481	1,435,676	1,181,743	2,344,487	951,185	1,527,810	1,156,322	3,175,950	7,972	26,554	3,956,703	8,510,477
Aug. 3- 9	761,954	1,550,517	1,816,287	3,720,433	422,148	712,151	1,276,081	3,691,097	11,590	40,478	4,288,060	9,714,676
Aug. 10-16	30,399	62,316	117,705	228,532	1,505	2,592	51,179	147,634	190	639	200,978	441,713
Total	11,971,142	24,124,783	17,164,967	32,915,406	13,199,218	18,858,413	3,342,345	9,066,720	45,123	155,173	45,722,795	85,120,495

Table 2. Catch of the Japanese mothership salmon fishery in Aleutian waters by month, area and species, in numbers of fish, with quantities of nets used, 1958.

Month	Area	Sockeye	Chum	Pink	Coho	Chinook	Total	Quantity of nets used (in tans (1))
May	B 608	89,189	361,126	1,689	..	190	452,194	107,237
	A 652	30,450	39,075	4,673	..	82	74,280	16,056
	A 650	379,037	322,014	5,149	..	312	706,512	215,145
	B 658	1,017,703	1,109,602	9,786	2	380	2,137,473	507,395
	B 656	438,240	515,872	18,439	2	162	972,715	268,160
	A 702	22,561	56,557	6,117	..	55	85,290	24,303
	A 700	181,191	336,727	12,800	..	121	530,839	171,028
	B 708	271,054	268,510	6,194	..	153	545,911	190,741
	B 706	92,167	95,797	2,852	..	30	190,846	63,942
	B 758	17,036	17,799	1,362	..	16	36,213	15,554
	Sub-total	2,538,628	3,123,079	69,061	4	1,501	5,732,273	1,579,561
June	A 550	47,591	275,021	464,536	88	502	787,738	94,996
	B 558	6,281	53,929	136,160	..	41	196,411	22,495
	A 604	133,399	93,226	72,012	..	846	299,483	84,305
	A 602	91,412	169,331	162,698	68	577	424,086	98,574
	A 600	273,774	339,997	440,353	192	725	1,055,041	212,009
	B 608	366,028	680,081	1,171,935	286	808	2,219,138	302,917
	A 652	201,626	207,474	49,606	17	519	459,242	140,600
	A 650	1,235,894	1,304,515	271,366	573	3,168	2,815,516	653,366
	B 658	1,668,841	1,296,046	459,538	2,442	1,828	3,428,695	683,645
	B 556	301,306	329,501	263,130	1,332	567	895,836	170,590
	A 702	238,904	635,687	89,582	12	946	965,131	214,332
	A 700	362,393	549,376	82,637	23	963	995,392	321,787
	B 708	135,886	115,675	13,951	..	272	265,784	65,539
	Sub-total	5,063,335	6,049,859	3,677,504	5,033	11,762	14,807,493	3,065,155
July	A 550	700,620	897,131	657,783	54,232	2,023	2,311,789	390,640
	B 558	311,454	1,626,342	3,922,989	116,432	3,693	5,980,910	786,633
	A 604	13,134	13,056	6,217	6	22	32,435	9,012
	A 602	126,317	151,936	67,312	225	512	346,302	62,431
	A 600	1,483,392	1,442,582	586,234	254,948	3,671	3,770,827	690,181
	B 608	253,329	1,154,145	3,204,666	494,185	5,105	5,111,430	698,045
	A 652	115,364	52,683	2,235	423	297	171,002	23,526
	A 650	187,342	119,867	17,517	56,181	269	381,176	68,603
	B 658	211,046	230,142	105,946	422,266	1,243	970,643	190,784
	B 656	14,204	84,527	254,597	261,011	920	615,259	86,119
	Sub-total	3,416,202	5,772,411	8,825,496	1,659,909	17,755	19,691,773	3,005,974
August	A 550	193,881	254,047	33,932	57,410	571	539,841	83,429
	B 558	625	13,577	57,854	1,908	27	73,991	8,712
	A 600	413,510	796,382	72,490	307,452	2,561	1,592,395	256,798
	B 608	4,409	183,391	77,606	190,188	1,161	456,755	92,017
	A 650	158,822	247,762	58,510	220,260	2,394	687,748	125,591
	B 658	28,223	236,978	107,234	390,956	2,358	765,749	145,043
	B 656	2,495	203,899	214,025	420,317	4,047	844,783	132,742
	A 702	45,547	111,650	597	7,712	363	165,869	32,700
	A 700	105,465	171,932	4,909	81,196	623	364,125	66,155
	Sub-total	952,977	2,219,618	627,157	1,677,399	14,105	5,491,256	943,187
Grand total		11,971,142	17,164,967	13,199,218	3,342,345	45,123	45,722,795	8,593,877

1) One tan measures approximately 170 feet at the float line.

of 52°N. and west of 170°E. until mid-August in order to investigate the distribution of immature salmon.

The stations occupied by the vessels are shown in Figure 2. The activities of both vessels are summarized as follows:

Name of Vessel	Cruise No.	Left Hakodate (Kushiro)	Began Investigations	Completed Investigations	Entered Hakodate (Kushiro)	Number of Stations
Wakashio-maru	1	May 10	May 20	July 2	(July 9)	28
	2	(July 15)	July 19	August 18	August 23	20
Kano-maru	1	May 10	May 18	June 30	(July 9)	25
	2	(July 15)	July 18	August 16	August 23	17

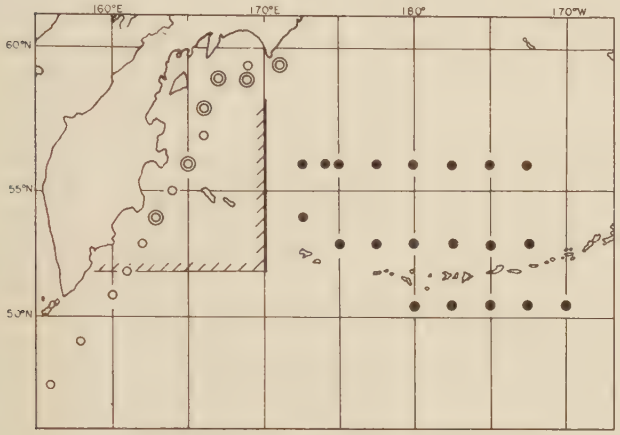


FIGURE 2. Research vessel stations.
Closed circles - 1st cruise of *Wakashio-maru*.
Open circles - 1st cruise of *Kano-maru*.
(Double circles indicate stations occupied twice)
Shaded areas - waters occupied by 2nd cruises of both vessels (individual stations are not shown).

Forty tans (170 feet per tan) of commercial drift nets (4.1 sun mesh or 4.9 inch mesh) were used together with the standard nets, which were made in conformity with an agreement between the three countries. The standard nets were composed of 2 tans (298 feet per tan) of 2½" nets, 2 tans of 3¼" nets, 6 tans of 4½" nets and 2 tans of 5¼" nets, connected in this order. However, in a considerable number of cases the amounts of 4½" nets and 5¼" nets were doubled. The detail of the results of fishing is shown in Table 3.

The relative abundance of sockeye salmon in 1958 was lower than in 1957. The catch-per-unit-of-effort in the Bering Sea during June was less than one fish per tan in almost all cases, except for somewhat higher catches-per-unit-of-effort at 53°N.-177°30'W. and 56°N.-172°30'W. In the waters off the Kamchatka Peninsula, including Olyutorski waters, the catch-per-unit-of-effort was less than one fish per tan in most cases during May and June.

Higher relative abundance was recorded for chum salmon than for sockeye. Differences in relative abundance by areas were fairly obvious. In the waters along the Kamchatka Peninsula, the highest relative abundance of chum salmon was seen near the tip of the Peninsula and the relative abundance decreased toward the north. In the mid-ocean areas, the relative abundance was generally higher in the Bering Sea than in the waters south of the Aleutian Islands. In the Bering Sea, sudden changes in relative abundance were seen between 172°W. and 175°W., along 53°N., and between 175°W. and 177°W., along 56°N.

1958 was a poor year for Asian pink salmon stocks and this was reflected in the extremely low relative abundance of pink salmon in the waters around the Aleutian Islands and in the offshore waters of the Bering Sea, compared with very large concentrations found in these waters in 1957. However, it should be noted that a rather high relative abundance was seen in Olyutorski waters. This makes us assume that when the abundance is low, the range of pink salmon distribution shrinks, but within the range the relative abundance does not decrease too much. However, this might have been caused simply by concentrations of fish coming shoreward in their spawning migration.

2. IDENTIFICATION OF STOCKS

A. Morphological Studies

(a) Collection and analysis of samples and data from mothership catches

In 1958, fifteen salmon motherships operated in Aleutian waters. On each of these motherships, body measurements and scale collections were made by a fishery inspector. For each species of salmon, a sample of thirty fish was taken every day. Length, weight and sex were determined for all specimens of the sample and gonad weight was measured for half of the sample. Scales were taken from all sockeye and chum and from one-third of the pink, coho and chinook. The analysis of age composition, length composition by age and sex, etc., is now progressing from the data and samples collected.

Table 3. Results of salmon fishing by research vessels, 1958.

Table 3-1: Wakashio-maru, 1st cruise

Date of hauling	Position of set Lat.	Long.	Time fished Started casting	Comp. hauling	Direction of set	Catch by 5¼ & 4½ nets & commercial nets: No. of tans	Sock-eye	Chum	Pink	Coho	Chin-ook	Total	Left: catch by 3¼ nets. Right: catch by 2½ nets: No. of tans		Sockeye		Chum		Pink		Coho		Chinook		Surface temp. (°C)
5-20	50-31N	179-45W	14-50	02-00	NW/N	48	1	42	8	..	..	51	2	2	..	..	..	..	..	..	..	..	..	..	5.1
5-24	50-19N	177-34W	14-50	02-25	SSW	54	37	63	17	..	1	118	2	2	..	..	..	..	3	..	..	..	..	..	4.9
5-27	50-30N	175-00W	15-15	02-40	E	54	25	10	22	..	..	57	2	2	..	..	..	..	3	..	..	..	..	..	5.3
5-28	50-30N	172-30W	15-30	02-30	NNE	54	27	35	21	..	..	83	2	2	..	..	..	..	..	..	..	..	..	..	5.7
5-30	50-30N	170-00W	15-15	02-15	NNE	52	2	19	1	..	..	22	2	2	..	1	..	..	..	..	..	..	..	..	5.2
6- 1	53-03N	172-00W	14-50	02-20	NNE	52	34	35	14	..	..	83	2	2	..	1	..	..	..	..	..	..	1	..	4.7
6- 2	53-02N	172-32W	14-57	02-30	NW/N	52	21	48	27	..	4	100	2	2	1	6	..	..	..	..	..	..	..	..	4.6
6- 3	53-00N	175-00W	14-57	02-27	SE	52	31	1	1	..	1	34	2	2	1	1	..	..	..	..	..	..	..	..	5.1
6- 4	53-00N	175-00W	14-40	02-05	SW/W	52	31	8	5	..	4	48	2	2	..	..	..	..	..	..	..	..	3	..	5.6
6- 8	53-00N	177-30W	14-54	03-15	SSW	50	78	4	7	..	1	90	2	2	1	3	..	..	..	..	..	..	..	..	5.1
6- 9	53-00N	180-00	15-31	02-25	S/E	50	17	8	11	..	..	36	2	2	..	..	..	..	..	..	..	..	..	..	4.6
6-10	52-54N	179-40W	15-15	02-22	S/E	50	22	20	9	..	..	51	2	2	..	..	..	..	..	..	..	..	..	..	4.6
6-11	53-00N	177-30E	15-45	02-20	SSW	50	9	19	8	..	..	36	2	2	..	..	..	..	1	..	..	..	..	..	5.0
6-12	52-57N	177-38E	15-25	02-15	S/E	50	12	10	2	..	..	24	2	2	..	..	..	..	..	..	..	..	..	..	4.9
6-13	53-00N	175-00E	15-33	02-10	SE	50	9	32	8	..	..	49	2	2	..	..	1	..	..	..	..	..	..	..	5.0
6-14	53-02N	174-56E	15-26	02-30	SE	50	11	166	4	..	1	182	2	2	..	..	3	..	1	..	..	..	..	..	5.2
6-15	54-00N	172-30E	15-30	02-30	ENE	50	15	96	10	..	..	121	2	2	..	1	..	..	1	..	..	..	..	..	5.4
6-18	56-00N	172-30W	15-30	02-23	NNW	50	79	22	18	..	..	119	2	2	2	2	..	1	..	..	..	..	4	..	6.5
6-19	56-00N	172-50W	15-30	01-43	SW/W	50	38	17	21	..	16	92	2	2	1	..	..	..	1	..	..	..	4	4	6.9
6-22	56-08N	175-00W	15-27	01-45	SSE	50	33	11	4	..	8	56	2	2	1	4	..	..	..	..	..	..	2	..	5.9
6-23	56-03N	177-26W	15-27	02-00	ESE	50	17	98	9	..	..	124	2	2	2	..	17	..	..	..	..	..	..	..	5.1
6-24	55-55N	179-57W	15-30	01-45	E	49	13	44	7	..	6	70	2	2	1	..	2	..	..	..	..	..	..	..	4.9
6-25	55-56N	179-58W	15-38	01-35	NE	49	9	76	6	..	2	93	2	2	..	..	7	..	..	..	..	..	..	..	5.1
6-26	56-00N	177-30E	15-28	01-40	SE	49	7	122	6	..	2	137	2	2	..	..	3	..	..	..	..	..	..	..	6.9
6-27	56-00N	175-00E	15-30	01-45	N	47	9	80	14	..	1	104	2	2	..	1	2	..	..	..	..	..	..	..	6.5
6-29	56-02N	174-10E	15-26	01-45	W/N	45	11	330	4	..	6	351	2	2	..	1	16	..	..	..	..	..	..	..	5.8
7- 1	56-00N	172-30E	15-33	01-35	SE/E	49	8	24	1	..	2	35	2	2	..	..	1	1	..	..	..	..	..	..	6.3
7- 2	56-00N	172-30E	15-30	01-45	N½E	49	11	62	11	..	..	84	2	2	..	..	1	..	..	..	..	..	..	..	6.3
Total						1,407	617	1,502	276	..	55	2,450	56	56	10	21	53	2	10				14	4	

Table 3-2: Kano-maru, 1st cruise

Date of hauling	Position of set Lat.	Long.	Time fished Started casting	Comp. hauling	Direction of set	Catch by 5¼ & 4½ nets & commercial nets No. of tans	Sock-eye	Chum	Pink	Coho	Chin-ook	Total	Left: catch by 3¼ nets. Right: catch by 2½ nets No. of tans		Sockeye		Chum		Pink		Coho		Chinook		Surface temp. (°C)
5-19	46-59N	156-01E	16-10	02-05	S	48	2	43	..	..	..	45	2	2	..	..	..	..	..	..	..	..	..	..	1.7
5-21	49-02N	157-53E	16-30	02-30	E/S	48	4	115	..	..	..	119	2	2	..	..	..	..	..	..	..	..	..	..	1.3
5-23	51-06.5N	159-57E	16-35	02-40	N/E	48	..	64	..	..	1	65	2	2	..	..	..	..	..	..	..	..	..	..	2.9
5-24	52-01N	160-45E	16-35	02-50	NNE	48	4	51	2	..	1	58	2	2	..	..	..	..	..	..	..	..	..	..	2.4
5-27	53-02N	161-57E	16-39	02-30	SSE	48	3	19	1	..	1	24	2	2	..	..	..	..	..	..	..	..	..	..	2.3
6- 1	53-45N	162-57E	17-45	03-00	S	48	11	13	..	..	..	24	2	2	..	..	..	..	..	..	..	..	..	..	2.5
6- 2	54-00N	163-00E	16-40	02-40	S/E	48	47	42	8	..	..	97	2	2	..	..	..	..	..	..	..	..	..	..	3.2
6- 4	55-02N	164-02E	16-47	02-30	NE	48	40	35	5	..	..	80	2	2	..	..	..	..	..	..	..	..	..	..	3.1
6- 5	56-01N	164-57E	17-00	02-40	S	48	30	4	15	..	1	50	2	2	..	..	..	..	..	..	..	..	..	..	4.0
6- 6	57-03N	166-03E	16-52	02-30	N	48	16	12	9	..	1	38	2	2	2	..	..	..	..	..	..	..	..	..	3.6
6- 7	57-54.5N	166-19E	16-42	02-10	N	48	14	16	9	..	..	39	2	2	..	..	..	..	1	..	..	..	..	..	3.4
6- 8	59-00N	166-57E	16-36	02-50	NNW	48	15	5	1	..	..	21	2	2	..	..	..	..	..	..	..	..	..	..	3.2
6-10	59-31N	169-00E	16-45	03-00	NW/N	48	22	4	16	..	2	44	2	2	..	..	..	..	..	..	..	..	..	..	3.8
6-11	59-27N	171-04E	16-40	02-50	W/S	48	15	4	5	..	1	25	2	..	..	..	..	..	..	..	..	..	..	..	4.3
6-12	59-28.5N	170-54E	16-26	03-10	W	48	14	1	3	..	1	19	2	..	..	..	..	..	..	..	..	..	..	..	3.9
6-13	59-20N	170-52E	16-37	02-00	SW	48	26	11	11	..	1	49	2	..	..	..	..	..	..	..	..	..	..	..	5.4
6-17	59-16.5N	169-03E	16-42	02-30	NW	51	51	14	84	..	..	149	2	..	1	..	..	..	6	..	..	..	..	..	5.2
6-18	59-29N	169-00E	16-37	02-30	N	51	29	8	48	..	..	85	2	..	1	..	..	..	2	..	..	..	..	..	5.2
6-19	58-52.5N	167-15E	16-45	02-40	N	51	27	23	61	..	..	111	2	2	2	..	..	..	..	..	..	..	..	..	5.4
6-20	58-56N	166-57E	17-00	02-30	N	51	24	20	90	..	3	137	2	2	..	..	..	..	3	..	..	..	..	..	6.1
6-21	59-01.5N	167-00E	17-15	02-50	NE	51	20	28	159	..	2	209	2	2	..	..	..	..	2	1	..	..	..	1	6.5
6-22	58-02N	166-03E	17-15	02-20	NNE	51	3	52	68	..	..	123	2	2	..	1	1	..	..	..	..	..	..	..	5.7
6-25	58-00N	166-00E	17-02	02-00	NNW	51	10	15	183	..	2	210	2	2	..	..	..	..	1	..	..	..	1	..	6.5
6-26	58-00N	166-00E	18-55	02-00	NW/W	51	10	13	396	..	..	419	2	2	..	..	..	..	..	..	..	..	..	..	6.4
6-30	56-01N	164-58E	17-05	02-30	NNE	51	10	29	55	..	1	95	2	2	..	..	..	..	..	..	..	..	..	..	6.3
Total						1,227	447	641	1,229	..	18	2,335	50	40	6	1	1	..	15	1	..	..	1	1	

Table 3-3: Wakashio-maru, 2nd cruise

Date of hauling	Position of set Lat.	Long.	Time fished Started casting	Comp. hauling	Direction of set	Catch by 5¼ & 4½ nets & commercial nets No. of tans	Sock-eye	Chum	Pink	Coho	Chin-ook	Total	Right: catch by 2½ nets. Left: catch by 3¼ nets No. of tans		Sockeye		Chum		Pink		Coho		Chinook		Surface temp. (°C)
7-19	46-30N	156-00E	16-54	04-15	SW/W	56	..	20	430	8	..	458	4	4	..	..	..	..	26	2	2	..	..	..	8.4
7-20	47-30N	156-30E	16-43	01-10	S/E	56	..	7	96	8	..	111	4	4	..	..	..	..	11	1	4	..	..	..	8.8
7-25	52-28N	168-58E	16-38	02-00	NW/N	56	126	54	1	21	..	202	4	4	21	..	33	9	..	..	2	..	1	..	8.6
7-29	52-03N	170-35E	16-43	03-00	SW	56	92	55	1	72	1	221	4	4	12	6	11	5	..	..	3	..	..	..	8.4
7-30	53-08N	171-44E	16-38	01-10	E/N	56	98	30	..	5	..	133	2	2	3	3	..	..	..	..	..	..	..	..	8.0
7-31	54-00N	171-00E	16-43	03-08	E/N	56	21	120	3	6	..	150	2	2	1	..	2	..	..	..	..	..	..	..	8.2
8- 1	54-00N	169-00E	16-43	03-00	N/E	56	106	68	..	2	..	176	2	2	12	1	1	..	..	..	..	..	..	..	7.9
8- 2	53-05N	169-00E	16-45	02-50	N	56	166	55	1	18	..	240	2	2	4	..	2	..	..	..	..	..	..	..	8.1
8- 5	54-05N	166-55E	16-48	03-00	N	56	99	37	1	11	..	148	2	2	10	..	4	..	..	..	..	..	..	..	9.1
8- 6	54-00N	165-00E	16-45	03-38	NE	56	273	61	2	40	1	377	2	2	10	1	3	..	..	..	..	..	..	..	9.4
8- 7	55-00N	164-00E	17-05	03-45	NE	56	95	21	..	29	..	145	2	2	3	1	..	..	..	..	..	1	..	..	9.4
8- 8	55-03N	164-05E	17-15	03-25	NW	56	261	57	1	6	2	327	2	2	18	10	19	3	..	..	..	..	..	..	10.0
8- 9	54-00N	163-00E	16-47	03-08	SW	56	281	96	5	56	..	438	2	2	16	4	13	2	..	..	..	..	..	..	10.0
8-10	53-00N	161-25E	16-53	03-35	N	56	59	55	1	28	..	143	2	2	5	1	7	..	..	..	2	..	..	..	10.4
8-11	53-00N	164-30E	16-52	04-00	NE	56	60	71	..	16	..	147	2	2	..	..	1	..	..	..	..	..	..	..	9.7
8-13	53-00N	167-10E	16-46	03-40	W/N	56	172	21	..	27	..	220	2	2	3	..	2	..	..	..	1	..	..	..	10.1
8-14	52-00N	166-00E	16-45	03-45	NE	56	85	44	1	8	..	138	2	2	1	..	1	..	..	..	..	..	..	..	9.6
8-15	52-00N	163-30E	16-44	04-10	N/W	56	54	42	..	12	2	110	2	2	1	..	2	..	..	..	1	..	..	..	10.2
8-17	51-55N	161-05E	16-43	03-46	E/S	56	100	24	1	20	..	145	2	2	10	1	..	..	..	..	2	..	..	..	10.8
8-18	51-56N	159-50E	16-49	04-10	N/E	56	49	17	1	39	..	106	2	2	6	1	..	..	..	..	1	..	..	..	11.9
Total						1,120	2,197	955	545	432	6	4,135	48	48	136	29	101	19	37	3	18	1	1	..	

Table 3-4: Kano-maru, 2nd cruise

Date of hauling	Position of set Lat.	Long.	Time fished Started casting	Comp. hauling	Direction of set	Catch by 5¼ & 4½ nets & commercial nets: No. of tans	Sock-eye	Chum	Pink	Coho	Chin-ook	Total	Left: catch by 3¼ nets. Right: catch by 2½ nets: No. of tans		Sockeye		Chum		Pink		Coho		Chinook		Surface temp. (°C)
7-19	46-56N	154-55E	17-26	02-50	S	53	..	27	157	7	..	191	2	2	..	..	1	..	1	1	..	..	..	..	7.8
7-20	47-33N	156-35E	17-00	03-30	WNW	53	..	10	239	7	..	256	2	2	9	7	..	1	..	1	..	..	..	..	9.1
7-29	55-00N	164-00E	17-20	03-00	N/E	53	140	13	..	6	..	159	2	2	14	22	4	3	2	..	..	..	..	..	8.3
7-31	59-18N	170-38E	17-30	03-30	SSW	53	163	120	1	..	3	287	2	2	11	..	44	7	..	..	..	..	..	..	9.5
8- 2	59-25N	169-04E	16-53	02-10	NNW	53	90	146	..	..	..	236	2	..	24	..	15	..	..	..	..	..	..	..	10.5
8- 3	58-51N	167-04E	17-02	02-35	W	53	110	50	2	1	..	163	2	..	22	22	34	..	..	..	..	..	..	..	9.1
8- 5	58-00N	166-00E	16-54	02-30	NNE	53	137	34	2	4	1	178	2	2	6	2	18	12	..	..	..	..	..	..	10.7
8- 6	58-00N	168-26E	16-56	02-25	N/E	53	85	24	1	2	..	112	2	2	14	1	13	5	..	..	..	..	..	..	10.3
8- 8	58-03N	171-00E	16-50	02-40	SSW	53	99	29	1	3	..	132	2	2	11	3	36	6	..	..	..	..	..	..	9.3
8- 9	57-00N	171-00E	16-34	02-40	S	53	126	15	..	..	..	141	2	2	8	..	11	8	..	..	..	..	..	..	8.9
8-10	57-02N	168-25E	19-00	03-05	N	53	82	28	..	..	..	110	2	2	24	5	17	..	..	..	..	..	..	..	8.9
8-11	56-58N	166-00E	16-47	03-00	N	53	111	15	..	..	..	126	2	2	..	..	5	3	..	..	..	..	..	..	10.5
8-12	56-06N	166-00E	17-00	03-04	WSW	53	3	4	..	1	..	8	2	2	3	..	1	..	..	..	..	..	..	..	10.1
8-13	55-56N	168-36E	16-52	03-02	E/N	53	40	29	1	2	..	72	2	2	4	..	12	3	..	..	..	..	..	..	10.1
8-14	56-00N	170-55E	16-43	02-54	SW	53	134	42	1	1	1	179	2	2	5	1	18	13	..	..	..	..	..	..	9.6
8-15	55-01N	170-58E	18-05	02-45	NNW	53	42	30	..	..	..	72	2	2	3	..	4	1	..	..	..	..	..	..	9.5
8-16	55-02N	169-25E	16-40	03-00	N	53	22	18	..	..	..	40	2	2	..	..	3	..	..	..	..	..	..	..	9.4
Total						901	1,384	634	405	34	5	2,462	34	30	158	63	236	62	3	2	..	..	..	..	

(b) Analysis of samples and data from research vessels

Age determination has been completed for chum salmon. As a result of the age analysis, it was found that the growth of the chum salmon found in Olyutorski waters was considerably faster than that of chum salmon found in other areas. It is indicated, at an intermediate stage of compilation, that the chum salmon caught during the first cruise of the *Kano-maru* in Olyutorski waters are about 3 cm. larger than those caught in the waters south of Cape Kamchatka, for the same ages. The chum salmon collected by the *Wakashio-maru* tend to be even smaller than those collected in the waters south of Cape Kamchatka for the same ages and, also, there is some interesting variation among the chum salmon caught by the *Wakashio-maru* in different areas. It is hoped that valuable suggestions on the origin of chum salmon found in offshore waters will be obtained by combining the above results with the data from motherships which are now being compiled. The analysis for sockeye and pink salmon has not yet been started.

Some valuable data on immature sockeye and chum salmon were obtained from the second cruises of the *Wakashio-maru* and the *Kano-maru* and the analysis of these data is now progressing.

B. Scale Studies

Sockeye salmon: The material used for analysis is the samples collected by motherships and research vessels during 1953 - 1957 and those obtained from Bristol Bay and the Kamchatka Peninsula in 1956. These scale samples are composed mostly of the age groups 4_2, 5_2, 5_3 and 6_3. Among these age groups, 4_2 and 5_3 include both spawning fish of the year and immature fish, which are to spend another year in the ocean, and it is assumed that there are differences in the scale pattern between these two categories of fish. Therefore, the scale analysis was made only for the age groups 5_2 and 6_3, which include practically only spawning fish of the year. Also, the scale samples from Bristol Bay were used as the standard American samples and those from the Kamchatka Peninsula and the Okhotsk Sea mothership fishery were used as the standard Asian samples.

Two characters were used for analysis. The first character was the size of the portion of the scale which is formed during the freshwater life (distance between nucleus and the last annulus of the freshwater zone along the symmetrical axis; RF) and the second character was the ratio of the scale portion representing the ocean growth to the total size of the scale (the ratio of the length of the ocean growth zone measured along the symmetrical axis to the distance between the nucleus and the last annulus along the same axis; IS_3/RS_3).

As a result of the analysis by RF, it was found that in the age group 6_3, more than 70% of the Asian sockeye had RF values of 0.4 mm., or less; whereas more than 70% of the American sockeye had RF values of 0.5 mm., or above. Furthermore, approximately 20% of the Asian sockeye had RF values of 0.3 mm., or less, which were rarely seen in American sockeye. Also, in the age group 5_2, more than 70% of the Asian sockeye had RF values of 0.3 mm., or less; whereas more than 70% of the American sockeye had RF values of 0.4 mm., or above. Furthermore, 30% of the Asian sockeye had RF values of 0.2 mm., or less; whereas fish of this category were not found among American sockeye. (Figure 3).

In the comparison using IS_3/RS_3, considerable overlapping was found in the frequency distribution of this value between Asian and American sockeye, but there was a notable difference in the mean value, Asian sockeye having a larger mean value than American sockeye.

The condition of intermingling of Asian and American sockeye on the high seas was determined from the RF composition. The results indicated that the proportion of Asian sockeye salmon was 100% between 160°E. and 164°E., 95% in the North Pacific between 170°E. and 175°E., about 40% in the Bering Sea between 175°E. and 180°, 80% in the North Pacific between the same longitudes, less than 20% in the Bering Sea between 180° and 175°W., and about 75% in the North Pacific between the same longitudes.

Analysis is not complete for the samples obtained from Bering Sea waters east of 175°W. On the Pacific side, according to an analysis of the scales of the 6_3 age group, collected by the *Tsukiyama-maru* in 1955, it is indicated that fish of Asian origin constituted approximately 70%. Judging from this result and from the relative abundance gradients of Asian sockeye in the waters west of this longitude, the distribution of Asian sockeye salmon seems to extend as far east as 170°W. in the Bering Sea and as far east as 165°W. in the North Pacific.

Chum salmon: Various types of analysis were carried out on the scales of four-year old fish obtained by government research vessels and motherships in 1955 and those obtained from Bristol Bay and Southeastern Alaska in the same year and from the scales of four and five year old fish obtained from motherships and U.S. research vessels in 1956 and those from various areas of Alaska in 1956.

Analysis was based on five characteristics: age; number of circuli in the first year zone

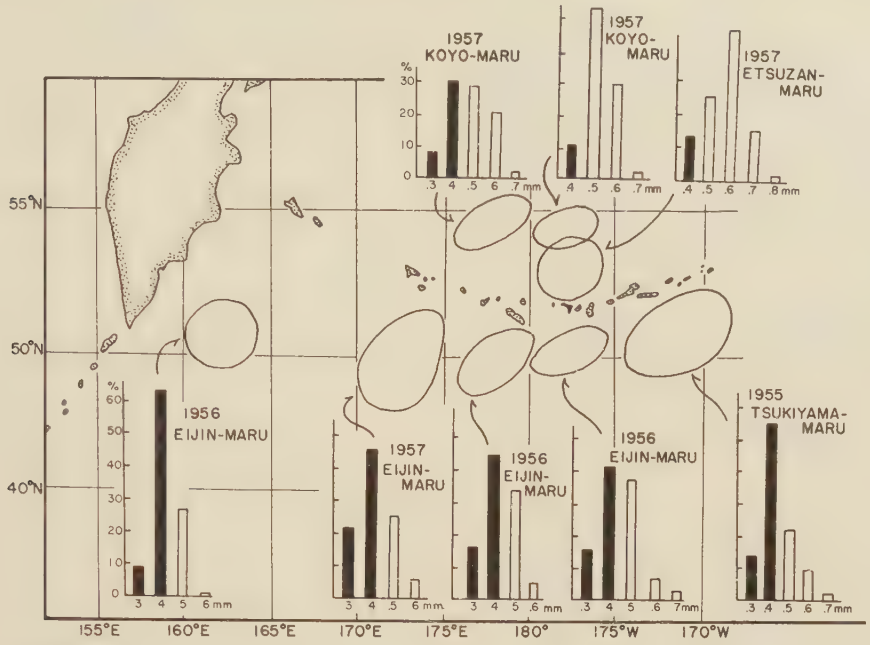


FIGURE 3. RF composition of 6_3 group in various areas of the high seas.

(CW_1) plus number of circuli in the second year zone (CW_2); CW_1 and CW_2 used separately; percentage ratio of the distance between the nucleus and the first annulus (R_1) to the distance between the nucleus and the second annulus (R_2), that is, $R_1/R_2 \times 100$; and $F_0/R_1 \times 100$ and S_0/F_0, as showing the growth formula of the first year, where F_0 represents the distance between the nucleus and the point corresponding to 30% of the number of circuli to the edge of the first annulus and S_0 represents the distance between the point corresponding to 30% and that corresponding to 60% of the same number of circuli. The results of comparisons using these five characteristics indicated that for each of these characteristics fairly obvious differences were present between the samples from waters west of 175°W. and those from northern Alaska and that more remarkable differences were present between the former samples and those from Southeastern Alaska. Inverse correlations are apparent between $R_0/R_1 \times 100$ and S_0/F_0; and differences between the above samples were statistically confirmed by comparing the positions and slopes of the regression lines and the centers of the ellipses obtained by applying normal equations for correlation surfaces.

Pink salmon: Before discussing the scale analysis, differences in pink salmon distribution in offshore waters between even years and odd years and differences in the body length and gonad weight between the samples obtained from different areas by motherships and research vessels were studied. As a result of these studies, it was shown that in even years large concentrations of pink salmon were found only in the southwestern part of the northern North Pacific (waters west of 170°E. and south of Cape Kronotskiy), excluding the Gulf of Alaska; while in odd years pink salmon were distributed in high relative abundance in the general areas of the North Pacific and Bering Sea west of 170° W. (probably further eastward in the North Pacific). In odd years, pink salmon found in the waters around the Aleutian Islands and in the Bering Sea had larger body lengths and gonad weights than those found in the southwestern part of the northern North Pacific. Comparing these results with the coastal catches and fishing seasons, it is assumed that pink salmon found in the waters around the Aleutian Islands and in the Bering Sea in odd years are mostly those going to East Kamchatka (chiefly the Olyutorski and Karaginski districts).

Based on certain preliminary studies up to 1957, two characters have been considered useful for distinguishing between pink salmon stocks. The first character is the number of circuli between the nucleus and the first annulus (N_1); and the second is the number of circuli included in a certain distance (0.05 cm.) immediately outside the annulus (N_2) which is considered to show the density of circuli formed there.

The above two characters were measured for as many scales as possible from the samples collec-

ted by motherships and research vessels in 1956 and 1957. The results indicate that pink salmon found in the southwestern part of the northern North Pacific and those found in large concentrations in the waters around the Aleutian Islands and in the Bering Sea in odd years show similar values for the above characters, in spite of differences in the time and area of sampling; whereas pink salmon from Alaska and British Columbia show differences from those caught from the above-indicated areas.

Summary of the results of scale studies: From the studies described above, the limits of distribution for salmon from both continents have been revealed to some extent for each of the three species, sockeye, chum and pink. The results can be summarized as follows:

Sockeye:

Asian fish: in the Bering Sea as far east as approximately 170°W. (1957); in the North Pacific as far east as approximately 165°W. (1956).

American fish: in the Bering Sea as far west as approximately 170°E. (1957); in the North Pacific as far west as approximately 175°E. (1956).

Chum:

Asian fish: as far east as approximately 175°-165°W.

American fish: as far west as approximately 175°-165°W.

Pink:

Asian fish: *in good years*; in the Bering Sea as far east as approximately 170°W.; in the North Pacific as far east as approximately 165°W.;
in poor years; the relative abundance in offshore waters is low, except in the southwestern part of the northern North Pacific.

American fish: in the North Pacific as far west as approximately 165°W.

From the above summary, it is obvious that, if we consider sockeye, chum and pink salmon, which are of commercial importance, representative of salmon species, salmon from Asia and those

Table 4. Incidence of parasites, by species, in various species of salmon

Parasite species		Sockeye	Pink	Chinook	Chum	Coho
Trematoda:	*Lecithaster gibbosus*				x	
Cestoda:	*Diphyllobothrium* (larvae)	x			x	
	Eubothrium spp.	x	x		x	
	Pelichnibothrium (larvae)				x	
	Phyllobothrium salmonis (larvae)	x			x	
	Proteocephalus (larvae)	x			x	
Nematoda:	*Anisakis salaris* (larvae)	x			x	
	Contracaecum spp.	x			x	x
	Cystidicola salmonicola				x	
	Metabronema sp.	x				
	Philonema ochotense	x				
	Philonema oncorhynchi	x				
	Rhabdochona sp.	x				
	Rhaphidascaris sp. (larvae)	x			x	
Acanthocephala:	*Bolbosoma* sp.	x				
	Rhadinorhynchus sp.				x	
Copepoda:	*Lepeophtheirus salmonis*	x	x		x	x

from America are intermingling in very wide areas between approximately 170°E. and 165°W. and that the range of distribution for salmon of each continental origin varies from species to species and also fluctuates rather remarkably from year to year.

It should be noted that the above results show only qualitatively the range of distribution of salmon from each continent, mostly based on scale studies, and, therefore, quantitative questions, such as the variations in the relative abundance of salmon from each continent by periods and by areas, cannot be answered as yet. Future studies should be in this direction.

C. Racial Studies Using Parasites

Salmon racial studies based on parasites, which were commenced in 1955, continued this year.

(1) Material for study

(a) Samples collected by research vessels in 1955 and 1956.

(b) Samples collected in eastern Hokkaido in 1957.

(c) Samples obtained from frozen whole fish samples shipped from the United States in 1958 and those obtained from salmon fry collected in Aomori Prefecture in 1958.

(2) Parasite species and parasite infection by fish species

Table 4 shows the species of parasites found in the five species of salmon—sockeye, chum, pink, coho and chinook—and the condition of parasite infection for each species of fish.

(3) Studies for distinguishing stocks

Up to the present time, the Japanese parasitological studies have been conducted by a small number of research workers using small samples. Therefore, the studies have not reached the stage where the question of distinguishing races of salmon can be discussed. However, *Lecithaster gibbosus,* which had been considered scarce in the western waters in the previous American and Canadian studies, was found in almost 100% of the chum salmon in Hokkaido, according to the Japanese studies. (However, the time of sampling was near the end of November in the Japanese studies and the species was chum, whereas the American and Canadian studies were based on samples of sockeye salmon collected in July and August.)

Also, *Echinorhynchus gadi,* which is a species of parasite generally abundant in the waters adjacent to Japan, was not collected at all in Hokkaido; certain specimens of *Rhadinorhynchus* sp., which resembles *Echinorhynchus* in appearance, were found.

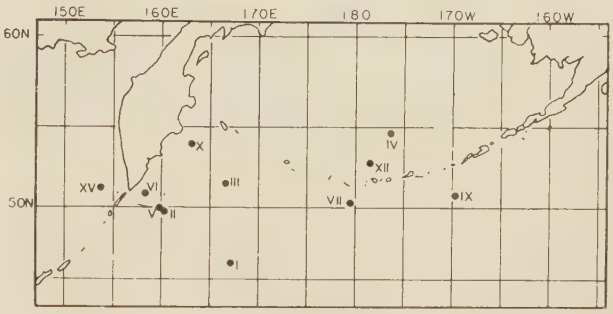


FIGURE 4. Location of 1957 high seas blood samples.

D. Serological Studies

The Japanese serological studies started in 1955; samples from the motherships and research vessels have been analyzed since 1956. At this moment, analysis has been completed for the samples up to 1957. A rough preliminary analysis of the samples collected in 1958 has been made.

Research results for 1956

(a) It was found that serological differences could be detected sharply by a serological method using haemoglobin solution as an antigen, in combination with the anti-serum absorption method.

(b) For chum salmon, the samples collected by the *Kosei-maru* (from Aleutain waters) and those collected by the *Tenyo-maru* (from the west coast of Kamchatka) showed only slight differences, indicating close relationships between each other, and the samples from the east coast of Hokkaido showed considerable serological differences from the above two groups of samples.

Research results for 1957

(a) Material: The analysis of the 1957 samples dealt principally with sockeye salmon. Samples were collected by the government research vessels *Etsuzan-maru, Kano-maru,* and the motherships *Tenyo-maru* and *Kyoho-maru.* The blood material processed aboard the *Kyoho-maru* was used as the antigen. Blood samples were collected from twenty specimens at each station. The locations and dates of sampling, etc., are shown in Table 5 and Figure 4.

(b) Method: Haemoglobin solutions were prepared by separating blood corpuscles on the vessels and were shipped frozen to the laboratory to be used for serological studies.

Anti-sera were prepared by immunizing rabbits with the above haemoglobin solutions. The antigen ring test was used for precipitation tests

Table 5. Date and location of collection.

Sample No.	Date of collection	Locations of collection	
I	5—25	46—12N	167—18E
II	6— 2	49—36N	160—13E
III	6—11	51—36N	166—38E
IV	6—23	54—38N	176—21W
V	7— 5	49—58N	159—59E
VI	7—13	50—52N	158—21E
VII	6—11	50—15N	179—30E
IX	6—21	50—53N	169—50W
X	8— 8	53—51N	163—03E
XII	6— 9	52—42N	178—26W
XV	7—15	51—04N	153—50E

Samples VIII, XI, XIII and XIV were deteriorated and not used.

Table 6. Reactions to the antiserum made by absorbing the antiserum "Sample II-344" with 0.5% volume of the antigen "Sample II-342".

Sample	II–342	343	344	345	346	347	348	349	350	351
PG_3	17	17	17	17	17	17	15	17	17	15
PG_6	15	15	15	15	15	15	15	15	15	15

Table 7. Reactions of the antigen "Kamchatka water Sample II" to the antiserum made by absorbing the Kamchatka antiserum "Sample II-344" with 0.5% volume of the antigen "Bering Sea Sample XII-323.

Sample II—	342	343	344	345	346	347	348	349	350
PG_3	15	15	15	15	15	15	15	15	15
PG_6	15	15	15	15	15	15	15	15	15

Table 8. Reactions of the antigen "Bering Sea Sample XII" to the antiserum made by absorbing the Kamchatka antiserum "Sample II-344" with 0.5% volume of the antigen "Bering Sea Sample XII-323".

Sample XII—	335	330	325	323	331	322	314	316
PG_3	13	13	13	13	13	13	13	13
PG_6	11	11	11	11	11	11	11	11

and the anti-serum absorption method was used in combination with the precipitation test.

(c) Summary of Results:

(i) It was found that the blood samples collected at the same station on the same day belonged to the same origin, as far as the samples analyzed were concerned.

(ii) The sockeye salmon samples from the Bering Sea (Samples IV and XII, collected from the vicinity of 176°W. and 178°W., respectively) showed remarkable serological differences from those collected from the waters south of the Aleutian Islands (Samples VII and IX, collected from the vicinity of 179°W. and 169°W., respectively).

(iii) The sockeye samples collected from waters close to the Kamchatka Peninsula were classified into three groups which serologically closely resembled each other:

Sample I (collected May 25)
Samples II, III, V and VI (collected June 2 - July 13)
Sample X (collected August 8).

(iv) The abovementioned samples taken from south of the Aleutian Islands showed serological differences from those taken from waters close to the Kamchatka Peninsula (Sample II was used as the standard for comparison), but the degree of dissimilarity was not larger than that seen between the three groups of samples from waters close to the Kamchatka Peninsula and was much smaller than the difference between the samples from south of the Aleutians and the samples from the Bering Sea. Therefore, it is indicated that these samples from south of the Aleutian Islands belong to a different origin from that of the samples from the Bering Sea and are more closely related to the samples from Kamchatka waters. (Tables 6, 7 and 8).

3. STUDY OF MOVEMENTS BY TAGGING

The tagging experiments in 1958 were conducted by the *Tenyo-maru* (Ministry of Agriculture and Forestry, 221.16 gross tons, 430 h.p.). The vessel left Hakodate on May 26 and returned to the same port on August 22.

(1) Gear used

In view of the low recapture rates from the tagging experiments using drift nets up to 1957 (6,155 fish were released in five years and 26 were recaptured, with a recapture rate of 0.42%), it was decided to use long-lines for catching fish to be tagged in 1958. However, salmon long-line fisheries up to the present time have been conducted by relatively small vessels, mostly less than 50 gross tons, in waters south of 48°N., and there has been little experience in long-line operations with larger vessels. For that reason, long-line operations by the *Tenyo-maru* were planned to be conducted both by dory fishing and by direct fishing from the main vessel. The gear for dory fishing was similar to that used by present long-line commercial vessels, employing finer main lines and shorter branch lines than those used when fishing directly from the main vessel. It was planned to fish directly from the main vessel in stormy or foggy weather.

The actual operation was conducted by both methods until early July, but thereafter the long-lines intended for dory fishing were set and hauled from the main vessel (although the efficiency of fishing was higher in dory fishing) and, also, the gear was gradually modified in order to improve fishing and handling efficiency. The description of the gear used at the final stage is as follows:

Gear Structure:

Main line: No. 20 count cotton yarn, 45 yarn, hard right-handed twist, stained with tannin, 510 feet per skate, including 5 feet extra on each end.

Branch line: No. 20 count cotton yarn, 24 yarns, 2.5 feet, 50 branch lines per skate at intervals of 10 feet.

Hook line: Synthetic line, diameter 0.571 mm., 1.5 feet long.

Hook: Pink salmon long-line hook, SWG diameter 4.00-3.10 mm., total length about 6 cm.

Float connecting line: No. 20 count cotton yarn, 36 yarns, directly connected to main line, 4 float connecting lines per skate.

Float: Ball 0.6 feet in diameter.

Basket: Circular flat bamboo basket with a diameter of 1.8 feet.

Fifty skates of long-lines of the above description were used daily (taking into consideration the time required for re-arranging lines after fishing). Salted anchovy was the principal bait. Squid and saury were used experimentally, but the fishing results were not at all comparable to those using anchovy as bait.

(2) Tag used, method of tagging and condition of fish tagged

Various types of tags were used during 1952-57 (such as pendant tags, Atkins tags, etc.). However, it was realized that vinyl tube tags as used by the United States since 1955, were the best with regard to the durability of tags and rate of recovery. Therefore, vinyl tags of this type, made in Japan, were used in the Japanese tagging experiments in 1958. However, since it was not possible to obtain suitable ink for permanently recording letters on these vinyl tubes in Japan, a red celluloid disc

Table 9. Catch and tagging data, by Tenyo-Maru, 1958.

Area	Period	No. of operations	No. of skates of long-lines used	Catch and release* (in numbers of fish)					
				Sockeye	Chum	Pink	Coho	Chinook	Total
A 49°N-52°N	6.5-6.19	15	557	73	364	59	1	4	501
A 175°W-175°E				82	485	104	1	8	680
B 48°N-53°N	6.25-7.24	21	930	336	570	184	25	6	1,121
B 157°E-172°E				416	870	273	40	8	1,607
C 51°N-56°N	7.29-8.18	18	865	728	777	..	123	1	1,629
C 160°E-166°E				900	1,172	3	172	2	2,249
Total		54	2,352	1,137	1,711	243	149	11	3,251
				1,398	2,527	380	213	18	4,536

*Upper figure: Number of fish released.
Lower figure: Catch in number of fish.

Table 10. Tag recoveries by areas of release (as of June 15, 1959). (Revised after scale checks)

Area of release	Species	Area of recapture: Mothership fishery: Off East Kamchatka	Mothership fishery: Off West Kamchatka	Offshore waters south of 48° N.	Coastal waters and streams: Alaska	Coastal waters and streams: Okhotsk: East Kam.	Okhotsk: West Kam.	Okhotsk: district	Sakhalin	Hokkaido	Total
A	Sockeye	3	..	..	4	..	..	..	..	..	7
A	Chum	6	..	..	1	2	2	..	..	..	11
A	Pink	..	..	..	1	..	..	..	..	..	1
A	Total	9	..	..	6	2	2	..	..	..	19
B	Sockeye	88	2	..	..	4	3	..	..	..	97
B	Chum	37	..	2	..	..	..	..	2	2*	43
B	Pink	32	10	2	..	..	..	..	..	..	44
B	Coho	6	..	..	..	..	1	1	..	..	8
B	Chinook	..	..	1	..	..	..	..	..	..	1
B	Total	163	12	5	..	4	4	1	2	2*	193
C	Sockeye	..	..	..	..	1	..	..	..	..	1
C	Chum	..	..	..	..	1	..	1	1	11	14
C	Coho	..	..	..	..	10	..	..	..	..	10
C	Total	..	..	..	..	12	..	1	1	11	25
Total	Sockeye	91	2	..	4	5	3	..	..	..	105
Total	Chum	43	..	2	1	3	2	1	3	13*	68
Total	Pink	32	10	2	1	..	..	..	..	..	45
Total	Coho	6	..	..	..	10	1	1	..	..	18
Total	Chinook	..	..	1	..	..	..	..	..	..	1
Total	Total	172	12	5	6	18	6	2	3	13*	237

*Including one fish recaptured at South Kurile.

with a diameter of 14 mm., with letters and figures, was attached to each tube by putting the latter through the former. The vinyl of the tube tags was 0.4 mm. in thickness and shinier than that of United States tags and tended to harden with decrease in temperature.

Fish caught by the long-lines were lifted by a scoop net, freed from the hook, placed on a tagging frame, the fork length was measured, a scale sample was taken and the fish was tagged with a tube tag and released thereafter. The time required after the fish was scooped was 40 to 50 seconds. When it was not possible to remove the hook without affecting the condition of the fish, the hook line was cut.

Most of the fish tagged were released in good condition. Poor condition of fish was caused by taking too much time to remove the hook or by a hook catching gill rakers.

(3) Number of fish caught, number of fish released, positions of release, etc.

The waters in which the *Tenyo-maru* conducted tagging experiments were grouped into three major areas: waters along the Pacific side of the Aleutian Islands between 175°E. and 175°W. (Area A); the mothership fishing grounds, namely waters between 48°N. and 53°N. and between 158°E. and 172°E. (Area B); and waters between 51°N. and 56°N. and between 159°E. and 166°E. (Area C). (See Figure 5).

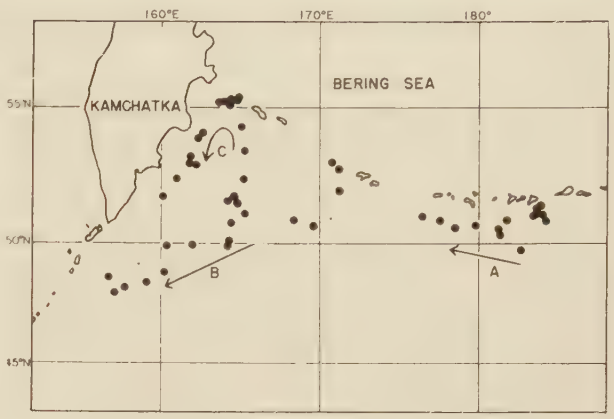


FIGURE 5. Tagging location, 1958.

The period of investigation, number of tagging operations, number of fish caught by species and number of fish released by species are shown in Table 9 for each of the above three areas. It is seen from this table that the catch-per-unit-of-effort

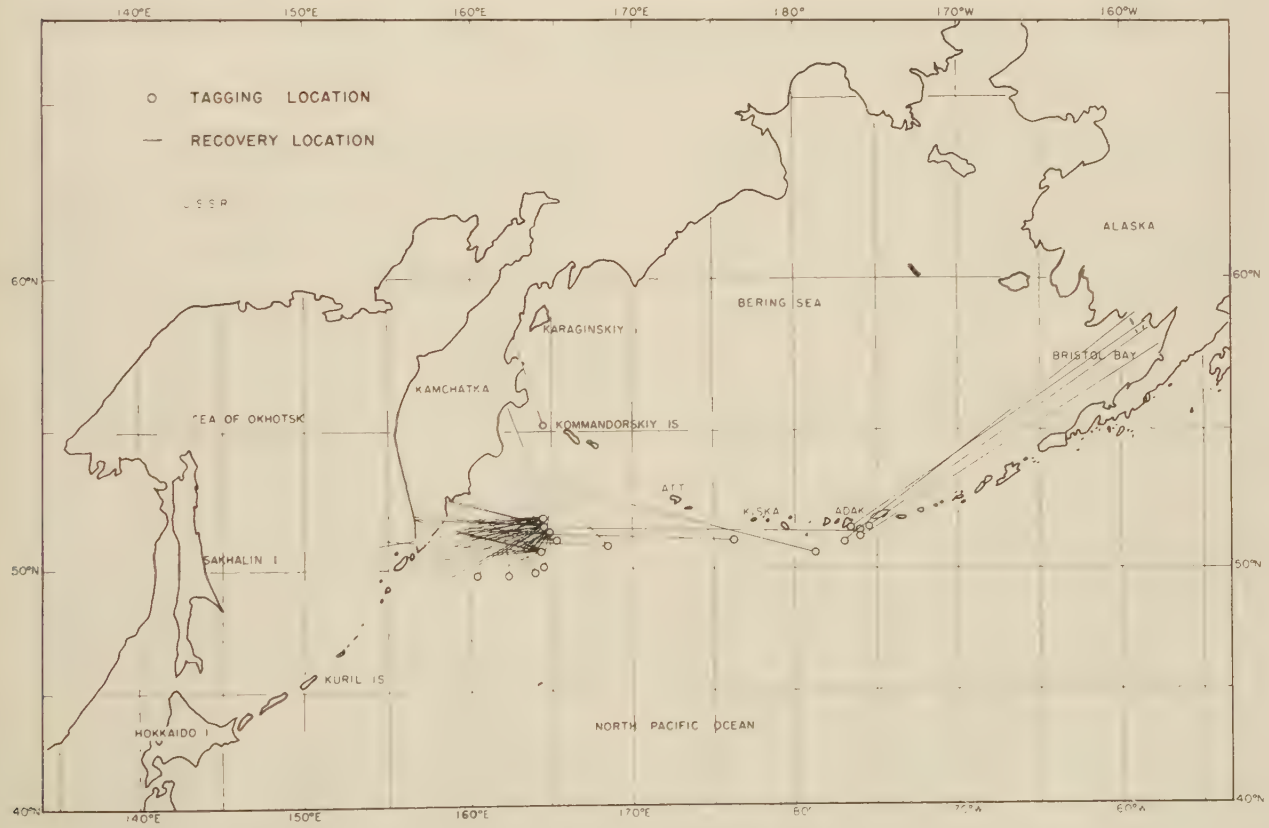


FIGURE 6. Sockeye salmon recoveries (1958 tagging) as of June 15, 1959.

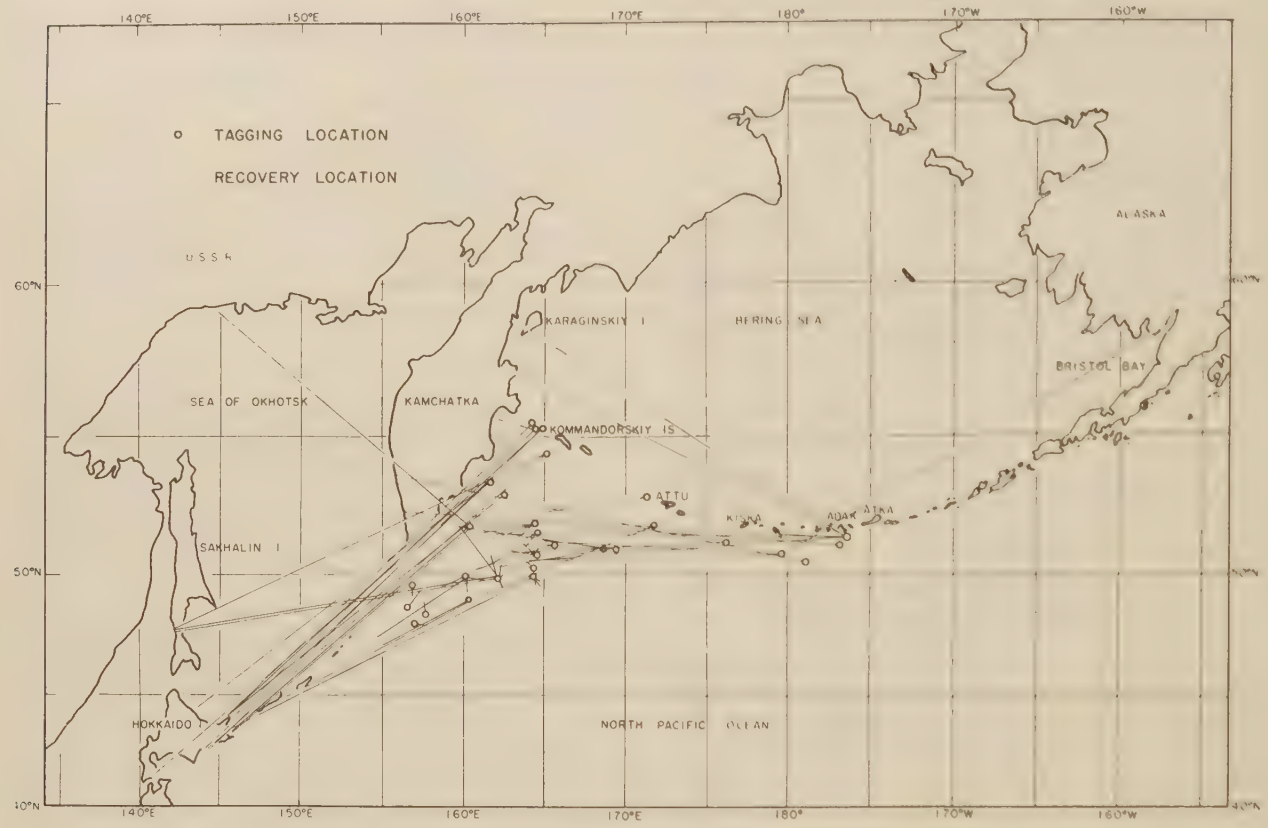


FIGURE 7 Chum salmon recoveries (1958 tagging) as of June 15, 1959.

increased in the order of Areas A, B and C (1.2, 1.7 and 2.6 per skate, respectively). However, since differences in the efficiency of bait fishing between mature and immature fish or between different species are not known, it is difficult to correctly determine the relative abundance of fish in various areas from the catches-per-unit-of-effort mentioned above.

(4) Results of recapture

The numbers of fish recaptured and reported as of June 15, 1959 are shown in Table 10 and Figures 6, 7 and 8.

Since the tagging experiments were limited in terms of both time and space, it is not possible, of course, to draw any definite conclusions on the migration routes of salmon from the above results. However, it has become fairly clear that the adult chum salmon found in Area C during late July through mid-August include considerable numbers of fish going to Hokkaido streams and, combining this with the results of United States tagging in 1956 and 1957 (which indicate close relationships between the mature chum salmon in Area A and the Hokkaido autumn chum salmon), that there is a major migration route going from Area A to Area C and southward to Hokkaido.

4. OCEANOGRAPHIC STUDIES

As a basis for studying the environmental structure for salmon it is necessary to study the structure of the ocean itself. In the first stages of the integral analysis of the oceanographic data collected by Japan, emphasis was placed upon the establishment of a static oceanic model. This is essential in order to proceed to the next stages of study, that is, the study of the mechanism of dynamic fluctuations of oceanographic conditions and their relationships to the ecology of salmon.

As early as 1934, 1935 and 1936, oceanographic investigations had been conducted in wide areas of the Bering Sea. Oceanographic investigations were resumed in 1952 and repeated observations have been made for six years, 1952 to 1957, mostly by the Fisheries Agency research vessel *Tenyo-maru* and the *Oshoro-maru*, training vessel of the Department of Fisheries of Hokkaido University.

In summarizing these data, the whole area of the northern North Pacific is divided into various characteristic regions by three remarkable oceanic fronts, namely Kuroshio extensions No. 1, No. 2 and No. 3. The waters south of Kuroshio extension No. 1, which extends eastward along 35°N., con-

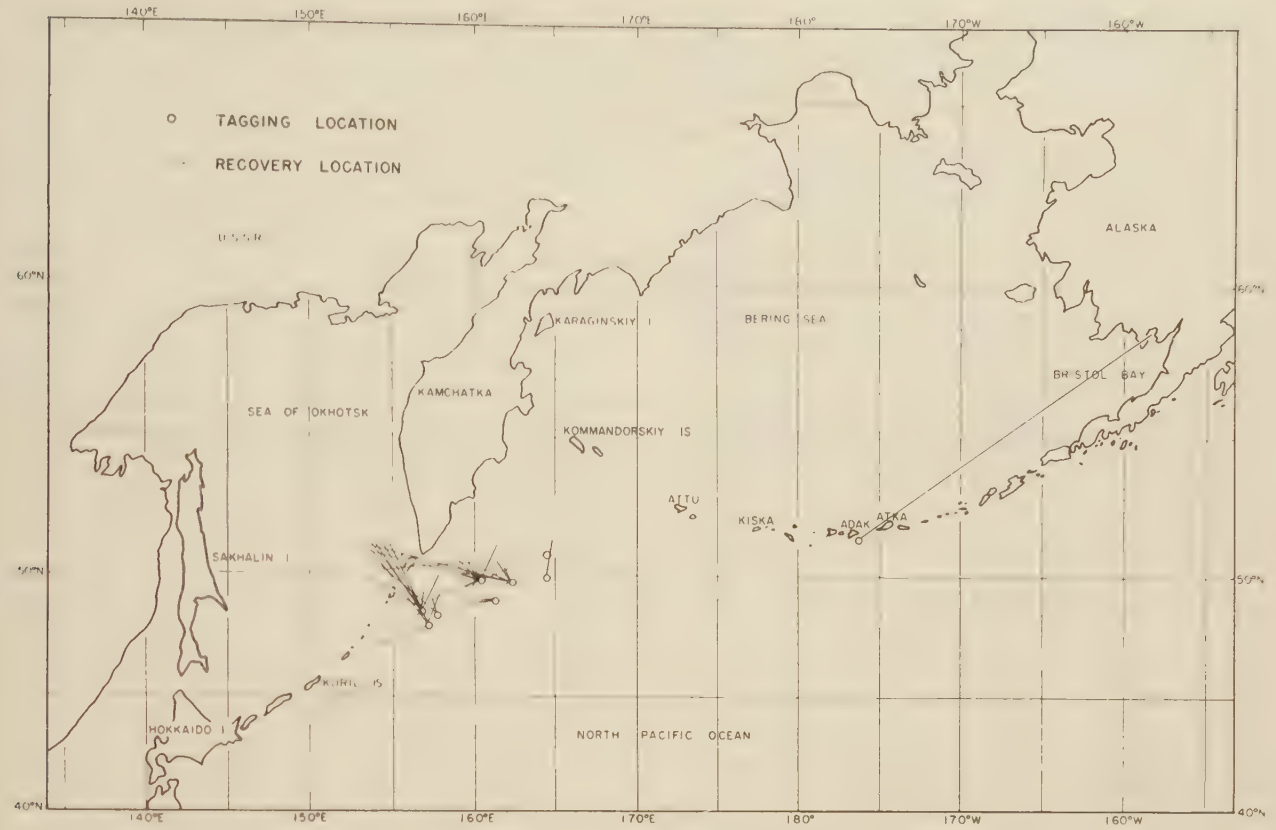


FIGURE 8. Pink salmon recoveries (1958 tagging) as of June 15, 1959.

stitute the sub-tropic region characterized by high temperature and salinity. A strong eastward current called an oceanic jet stream exists along Kuroshio extension No. 1. Kuroshio extension No. 2 extends eastward approximately along 40°N. in the waters adjacent to Hokkaido, reaches the vicinity of 45°N. at around 155°E., and runs further eastward. It tends to shift somewhat southward in the waters east of 180°. Kuroshio extension No. 2 is not accompanied by an oceanic jet stream as is Kuroshio extension No. 1, but it maintains marked temperature gradients in the waters adjacent to Hokkaido. The waters between Kuroshio extensions No. 1 and No. 2 are called the intermediate region and strong intermingling of cold and warm water masses occurs here. Kuroshio extension No. 3 branches from Kuroshio extension No. 2 and extends northeastward. If we can assume that Kuroshio extensions No. 1, No. 2 and No. 3 constitute oceanic filaments, then this whole area of the northern North Pacific is considered to form a shingling structure.

The returning flow becomes a strong northward current between 180° and 170°W. and thereafter turns east. The current then goes northwestward along the continental slope on the western side of the Alaska Peninsula and thereafter shifts to southwestward and passes offshore along the eastern coast of the Kamchatka Peninsula to reach Kurile waters.

A shelf water mass occurs on the continental shelf on the western side of the Alaska Peninsula, forming a clearly defined oceanic front along the continental slope at the boundary with the Bering water mass.

Since surface waters are greatly cooled in winter, it is assumed that most salmon find their wintering grounds in the warmer waters south of Kuroshio extension No. 2. As the temperature in the surface layer sharply rises in spring and summer, the optimum temperature zone for salmon also extends toward northern waters. From spring to autumn the seaward migration of young fish from various streams of the Asian continent and the Alaska Peninsula and the migration of spawning fish into these streams takes place. Thereafter salmon again move south, avoiding unfavorable conditions, toward the productive southern frontal zone to spend the winter there.

The plan for oceanographic investigations in 1958 was established with sufficient consideration given to the I.G.Y. program and the programs of oceanographic observations by Canada and the United States. Information was exchanged before

finalizing the plans and, in deciding the stations, duplication of the areas to be occupied was avoided as much as possible in order to make a synoptic study of the oceanographic structure.

The *Hokusei-maru* operated in the waters of the northwestern Pacific during the period May 13 through August 21 and such activities as temperature and salinity observations at each depth, plankton collection, larvae collection, weather observations and water colour and transparency observations were carried out at a total of 106 stations. The *Oshoro-maru* occupied 22 stations, mostly in the central part of the Bering Sea, during the period May 26 through July 9, and temperature and salinity observations at each depth, plankton collection, larvae collection, weather observations, determination of water colour and transparency, bathythermograph observations, geoelectric kinetigraph observations, determination of turbidity, general water sampling and specific water sampling were conducted. Water temperature observations by bathythermograph were made by the biological research vessels *Kano-maru* and *Wakashio-maru* during the period from May 20 to August 21 and by the *Tenyo-maru* during the period from May 23 to August 23. The data obtained from these investigations are now being analyzed by the respective agencies.

In the future, the three countries should attempt to study the dynamic structure of the ocean controlling the salmon resources of the North Pacific. A more intensive exchange of information is desired in order to further the purposes of cooperative international observations.

REPORT OF RESEARCH ON KING CRAB IN THE EASTERN BERING SEA

Fisheries Agency of Japan

Research in 1958 was conducted by a research worker who was aboard the crab mothership as in the last year.

Collection and Analysis of Records of Commercial Catches

(1) Records of fishing operations

The king crab tangle net fishing grounds are shown in Figure 1 and the catch by month is shown in Table 1. In 1958, bad weather frequently interrupted the operation, which was rather unusual, but canned crab production reached the target in a very short period of time as in 1957. The average number of male crabs caught per shackle of tangle nets (one shackle measures about 130 feet at the lead line) was not quite as high as that of 1957, but at a relatively high level compared to past years (see Figure 2).

During the period 1953-56, the catch from the crab grounds around Amak Island was at most one-fourth of the total catch and as little as one-tenth of the total catch. However, from 1957 onward, the catch from these grounds has increased and exceeded one-half of the total catch in 1958. The production of canned king crab (see Table 2) was 59,850 cases; 377 cases of canned tanner crab were also produced, in the early part of the season.

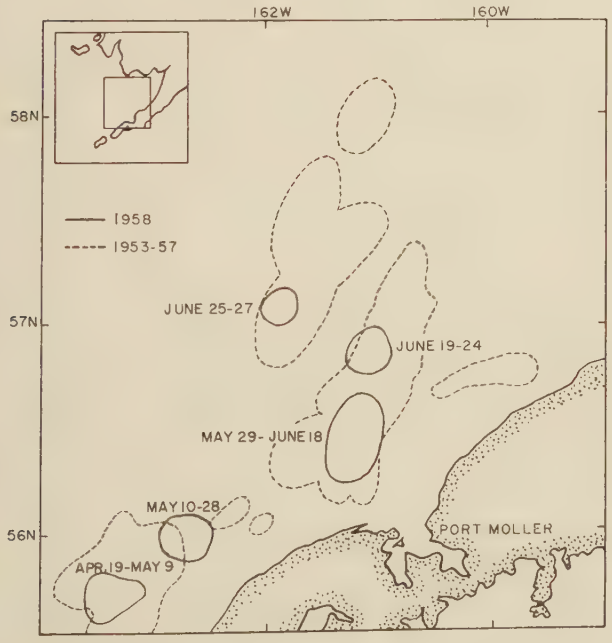


FIGURE 1. Tangle net grounds, 1958.

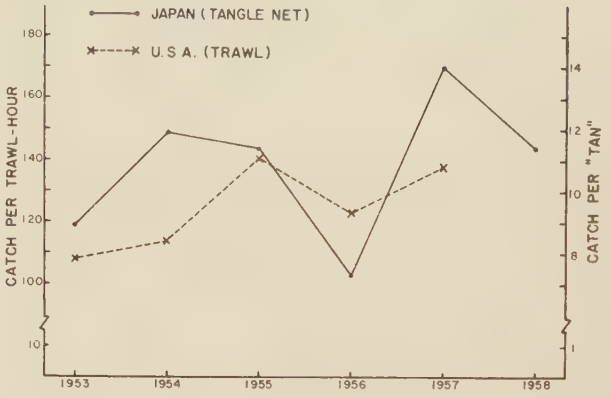


FIGURE 2. Catch-per-effort, 1953-1958.

(2) Catch composition

The small amounts of tangle nets (5 shackles per set) set in wider areas for short periods of time, for the purpose of locating crab schools, are called scouting nets. From the records of the scouting net catches, proportions of male crabs (male crabs of 130 mm. or above in maximum carapace width), new-shelled males (male crabs of 130 mm. or above in maximum carapace width with a new shell), under-sized males (male crabs of less than 130 mm. in maximum carapace width), female crabs and tanner crabs were determined (see Table 3). An increase in the proportion of tanner crabs in April was probably related to the production of canned tanner crab in the early part of the season, and the early completion of the operation was probably due to the generally low proportion, even lower than in 1957, of undersized males.

In the 1957 Annual Report, it was stated that there was a fair coincidence between the yearly fluctuations in the average number of female crabs per shackle of tangle nets and those of scouting nets. However, in 1958 the catch per shackle of tangle nets decreased from that of 1957, while the catch per shackle of scouting nets increased from that of 1957. It is assumed that this inverse trend was caused by decreased efficiency of the tangle net operation, due to frequent storms during the 1958 season and also by smaller numbers of operations by scouting nets in 1958, which made fishing effort concentrate in areas of high crab concentrations.

Identification of Stocks

The carapace length was measured for 2,600 sample crabs taken from the catch. The mean cara-

pace lengths for the years 1953 through 1958 are shown in Table 4 and the carapace length frequency distribution is shown in Figure 3. There is only one mode in the carapace length frequency distribution, but it is considered to be caused by selective fishing by tangle nets for relatively large crabs. The above figure and table seem to indicate a tendency for decrease in the size of crabs from year to year, although the degree of decrease is very small.

In 1957, 3,084 juvenile crabs were collected during the period of May 29 through June 15, of which 2,686 were measurable. The carapace length frequency distribution for these juvenile crabs is shown in Figure 4. A mode is seen at 9 mm. for both sexes.

Table 1. King crab catch by month, 1958.

Period	No. of tans hauled**	No. of days net soaked	No. of crabs caught	Catch per tan	No. of cases packed
April 19* — 30	15,630	7.0	157,260	10.1	8,390
May 5 — 31	39,394	15.1	497,361	12.6	26,277
June 1 — 27	43,651	13.1	475,032	10.9	25,183
TOTAL	98,675	13.0	1,129,653	11.4	59,850

* Date of beginning of hauling.

** "Tan" is a unit of tangle-nets, one tan measuring about 130 feet at the lead line.

Table 2. Canned crab production.

* No. of days operated	No. of motherships	** No. of independent boats	*** No. of deck-loaded boats	No. of tans hauled	No. of crabs caught	Catch per tan	**** No. of cases packed	No. of crabs per case
72	1 (5,386 g.t.)	2	8	98,675	1,129,653	11.4	59,850	18.9

* April 17 — June 27.

** Engaged in setting tangle-nets and scouting nets and hauling scouting nets.

*** Engaged in hauling tangle-nets.

**** In terms of cases of 48 half-pound cans each. This year 29,766 cases of 48 half-pound cans each and 30,084 cases of 24 one-pound cans each were packed. Also, 377 cases of tanner crabs of 48 half-pound cans each were packed.

Table 3. Composition of catch by scouting nets, 1958.

* Month	No. of operations	No. of tans hauled	No. of crabs caught	Catch composition %				
				Males	New-shelled males	Undersized males	Females	Tanner crabs
April	113	565	7,766	46.2	1.2	2.8	11.6	38.2
May	88	435.5	10,028	70.7	0.2	5.4	13.2	10.5
June	101	505	6,703	70.3	0.1	10.2	15.3	4.1
Total	302	1,505.5	24,497	62.8	0.5	5.9	13.3	17.5

* April 13 — June 21

Table 4. Average carapace length of male crabs of legal size.

Year	No. of crabs measured	Average carapace length
1953	4,119	170.2 mm.
1954	2,877	166.5
1955	4,500	164.1
1956	5,640	162.5
1957	4,720	159.8
1958	2,600	158.9

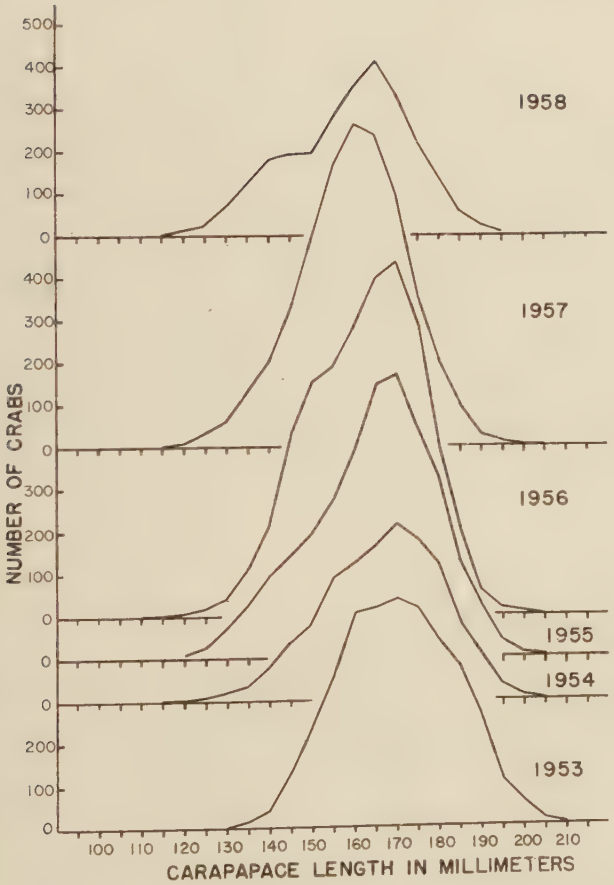


FIGURE 3. Carapace length frequencies of male crabs, 1953-1958.

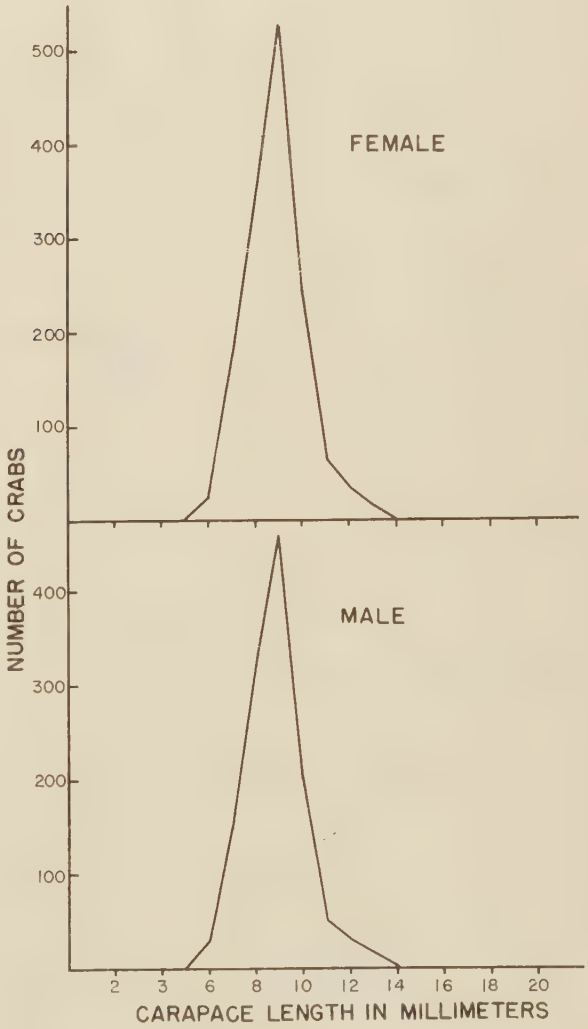


FIGURE 4. Size frequencies of juvenile crabs, 1957.

Relation of Current to Distribution and Dispersal of Young

A total of 2,096 juvenile crabs were collected in 1958 in the same way as in 1957. The areas from which these crabs were collected are shown in Figure 5 and they are approximately the same as in previous years. In addition to the collection of juvenile crabs, the measurement of tidal currents, water sampling and plankton collection were conducted on the crab grounds. The bottom temperature and depth are shown for various tangle net grounds in Table 5. The bottom temperature on the crab grounds was, in general, higher than usual.

Study of Movements by Tagging

From 1,897 crabs tagged in 1957, 13 were recaptured in 1958. One of these 13 crabs had moulted and shown growth.

FIGURE 5. Areas in which juvenile crabs were collected, 1958.

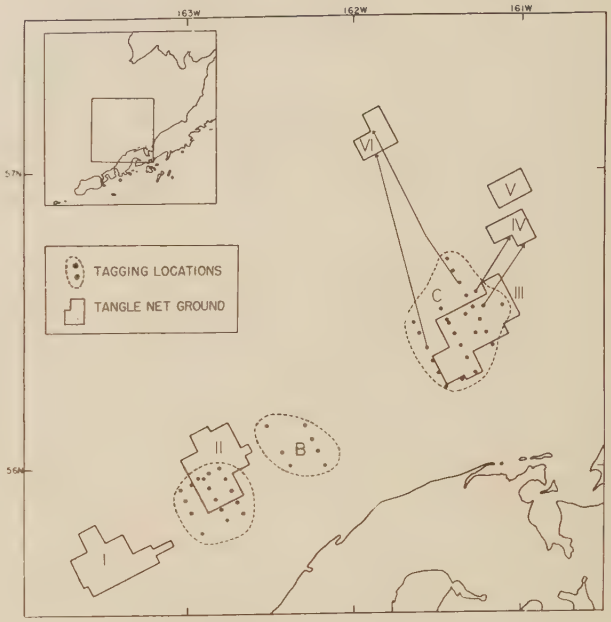


FIGURE 6. Tagging, 1958.

In 1958, for the purpose of studying crab movements during the fishing season, 973 male crabs of commercial size caught by scouting nets were tagged by fixing a celluloid tag to the meropodite of a walking leg with a wire. Among 300 crabs released in Area A (see Figure 6 and Table 6), 78 were recaptured in tangle net ground II and there were no recaptures from this lot in other grounds. There was no recapture from 100 crabs released in Area B. From 573 released in Area C, 58 were recaptured in tangle net ground III, 2 in ground IV and 2 in ground VI. From these recapture records, no consistent trend in crab movements was found within the tangle net grounds. It seems crabs move faster during the latter half of the season than the first half of the season.

Table 5. Bottom temperature and depth, 1958.

Period	Location *	Average bottom temp.	Average depth	No. of observations
April 19 — May 9	Vicinity of Amak I.	2.73°C.	84.9 m.	14
May 10 — May 28	Off Blackhill	2.73	82.2	18
May 29 — June 18	Off Port Moller	4.17	68.8	19
June 19 — June 24	Off Port Moller	3.75	68.5	6
June 25 — June 27	Off Port Moller	5.17	55.3	3

* See Figure 1.

Table 6. Tagging, 1958.

Area	Date of release	No. of crabs released	No. of crabs recaptured
A	April 26—27	300	78
B	May 8	100	0
C	May 10—12, June 2	573	62

Tangle-net ground	Period of fishing		No. of crabs recaptured
	Setting nets	Hauling nets	
I	April 14—26	April 19—May 9	..
II	April 26—May 12, May 27	May 10—28	78
III	May 12—June 1	May 29—June 18	58
IV	June 8—13	June 19—21	2
V	June 15—17	June 22—24	..
VI	June 19—22	June 25—27	2

C. REPORT ON THE INVESTIGATIONS BY THE UNITED STATES FOR THE INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION - 1958

The studies on red, chum and pink salmon for the past several years by the scientists of Canada, Japan and the United States have resulted in a better understanding of these species. The range and distribution of salmon on the high seas is much better known, and we are recognizing some of the marked variations in their distribution and changes in the hydrography of the North Pacific Ocean and Bering Sea which probably influence these variations. Starting with little means of identifying the continental origin of high seas salmon, we now have available several techniques to determine where the fish originated.

As a result, we have undergone a gradual but significant shift in the emphasis of our research work. Initially, we were concerned with discovering whether there is an appreciable overlap in the high seas distribution of Asiatic and North American salmon and with developing the tools for identifying the origin of these fish. We have reached the stage where it is necessary to determine quantitatively the numbers of fish at different times and places according to origin. A careful study of the problems of providing quantitative results is under way. The account of progress which follows briefly summarizes the status of our studies.

DISTRIBUTION AND RACIAL SAMPLING OF SALMON ON THE HIGH SEAS

Vessel Operations

Vessels chartered for the 1958 season were two of the same schooners used in 1957 (MV *Attu*, 55 gross tons, and MV *Pioneer*, 72 gross tons). Each vessel fished 24 shackles of gill nets set with 4½" mesh in all odd numbered shackles. Even numbered shackles were of 5¼, 3¼ and 2½ inch mesh; the pattern was repeated every 6 shackles. In addition, one shackle, an experimental deep net, was fished by the MV *Attu*. This net stretched from the surface to a depth of 52 feet.

In order to obtain maximum fishing effort and area coverage with two vessels, less emphasis was placed this year on adherence to a fixed station

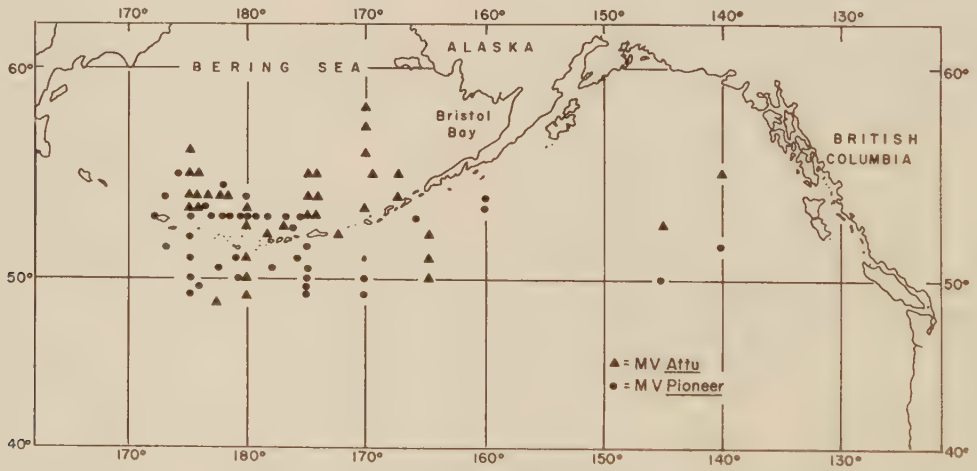


Figure 1. Fishing stations of M.V. *Attu* and M.V. *Pioneer* during the 1958 season.

Table 1. Comparative catches of MV *Pioneer* and MV *Attu*.

	Reds	Chums	Pinks	Totals
MV *Pioneer*				
1957 — 38 sets	1,391	2,818	2,155	6,364
1958 — 41 sets	736	2,242	107	3,085
MV *Attu*				
1957 — 37 sets	1,443	1,377	1,013	3,833
1958 — 37 sets	454	1,635	87	2,176

pattern. Since the season was unusually stormy, this procedure proved effective, enabling the two vessels to complete 78 sets compared with the 75 sets during the slightly longer 1957 season. The area of operation and the approximate locations of the gill net sets are shown in Figure 1.

Salmon Catches and Distribution

When compared with 1957, catches in 1958 reflect a marked decline in the abundance of reds and an even greater decline in the abundance of pinks. Chums were found in comparable numbers both years. The comparative catches of the MV *Pioneer* and MV *Attu* are shown in Table 1.

Details of the 1958 catches are shown in Tables 2 and 3.

Red salmon

Although the red salmon catches in 1958 showed a marked decline, the distribution of matures and juveniles in the Bering Sea and the North Pacific was similar to that of previous years. The majority of the mature red salmon were caught during May and June in both areas, and most of the juveniles (fish with a single ocean annulus) were caught during July and August south of the Aleutian Chain.

Table 2. Salmon catches by United States research vessel MV *Attu*, May 27 through August 27, 1958.

Set		Position		No. of	Surface temp.	Number of salmon caught						Deep net[3]	
No.	Date[1]	Lat. N.	Long.	shackles	°C[2]	Red	Chum	Pink	Silver	King	Total	Top	Bot.
1	May 28	51°00′	180°	24	5.1	10	8	2	..	..	20	*	*
2	May 29	50°03′	180°	24	5.2	9	37	2	..	..	48	*	*
3	May 31	49°00′	180°	24	4.8	7	45	9	..	..	61	*	*
4	June 1	48°33′	178°29′E	24	4.7	3	18	..	..	..	21	*	*
5	June 8	53°07′	175°02′E	24	4.7	11	30	18	..	..	59	*	*
6	June 10	54°00′	178°00′W	24	5.3	11	4	5	..	..	20	*	*
7	June 17	53°30′	170°02′W	24	6.3	51	37	30	..	2	120	3R,1C	1R,1C
8	June 18	53°59′	167°32′W	24	6.9	..	..	..	..	..	..	*	*
9	June 24	54°59′	167°22′W	24	6.7	2	5	..	..	..	7	*	*
10	June 25	55°04′	169°24′W	24	6.6	84	16	5	..	..	105	*	*
11	June 26	55°58′	170°04′W	24	6.8	25	26	5	..	1	57	*	*
12	June 27	56°57′	169°58′W	24	6.8	3	1	..	..	..	4	*	*
13	June 28	57°59′	169°59′W	24	6.5	2	..	..	..	..	2	*	*
14	June 30	55°04′	174°52′W	24	6.3	2	3	..	..	1	6	*	*
15	July 1	53°58′	175°00′W	24	6.7	..	4	4	..	..	8	*	*
16	July 2	53°01′	175°00′W	24	6.8	7	2	..	..	1	10	*	*
17	July 11	52°25′	177°02′W	24	6.7	1	13	..	..	..	14	*	*
18	July 12	52°04′	178°38′W	24	7.2	14	17	..	..	..	31	*	*
19	July 13	52°31′	179°59′W	24	6.4	2	59	..	..	..	61	*	*
20	July 14	53°31′	180°	24	6.5	28	325	3	..	..	356	*	*
21	July 15	54°00′	178°00′E	24	7.3	17	52	2	..	..	71	*	*
22	July 16	54°02′	176°28′E	24	8.0	1	112	..	..	..	113	0	0
23	July 17	54°00′	175°00′E	24	8.9	6	186	..	..	..	192	*	*
24	July 18	55°00′	175°00′E	24	8.5	16	151	..	..	1	168	*	*
25	July 19	55°59′	175°01′E	24	8.5	5	125	..	..	..	130	*	*
26	July 20	55°01′	174°58′E	24	8.8	2	76	..	1	1	80	*	*
27	July 21	54°00′	174°58′E	24	9.1	2	67	2	2	..	73	1C	0
28	July 22	53°21′	174°04′E	24	8.2	2	28	..	..	..	30	*	*
29	Aug 5	53°00′	174°59′W	24	8.8	8	69	..	..	..	77	*	*
30	Aug 6	54°00′	175°00′W	24	9.0	..	..	..	..	..	..	*	*
31	Aug 7	55°00′	175°00′W	24	9.0	14	16	..	..	..	30	*	*
32	Aug 10	52°00′	172°30′W	24	6.6	..	..	..	..	..	..	*	*
33	Aug 17	52°00′	165°00′W	24	13.6	42	65	..	..	..	107	2R,2C	0
34	Aug 18	51°00′	165°00′W	24	10.2	31	17	..	..	1	49	5R	1R
35	Aug 19	50°00′	165°00′W	23	9.8	34	21	..	..	..	55	3R	0
36	Aug 25	52°35′	145°03′W	22	11.8	..	2	..	..	..	2	*	*
37	Aug 27	55°00′	140°00′W	22	14.1	..	..	..	1	..	1	*	*
Totals						454	1635	87	4	8	2188	13R,4C	2R,1C

1. Date hauled.
2. Temperature readings at time of set.
3. One shackle of 4½″ mesh net - 300 ft. long & 40 ft. deep Top=upper 20 ft., Bot.=bottom 20 ft. Asterisk (*)=net not fished. Letter R=red salmon, Letter C=chum salmon.

Table 3. Salmon catches by United States research vessel MV *Pioneer* May 27 through August 27, 1958

Set No.	Date[1]	Position Lat. N.	Position Long.	No. of shackles	Surface temp.°C[2]	Number of salmon caught Red	Chum	Pink	Silver	King	Total
1	May 28	53°00′	180°	24	3.3	6	2	9	..	..	17
2	May 29	53°00′	178°15′E	24	3.2	6	..	1	..	..	7
3	May 31	55°00′	174°00′E	24	2.7	5	3	2	..	..	10
4	June 1	54°00′	173°00′E	24	3.6	18	4	1	..	5	28
5	June 2	53°00′	172°00′E	24	3.6	12	28	1	..	..	41
6	June 8	51°35′	173°00′E	24	4.6	12	46	29	..	1	88
7	June 17	53°00′	180°	24	5.1	4	66	7	1	1	79
8	June 18	54°00′	180°	24	6.3	12	53	13	..	1	79
9	June 22	54°43′	178°14′E	24	4.6	10	72	5	..	1	88
10	June 30	50°00′	180°	24	5.9	44	99	..	2	..	145
11	July 6	51°17′	175°53′W	24	7.0	39	48	3	..	..	90
12	July 7	50°30′	175°00′W	24	7.1	18	169	8	1	..	196
13	July 8	49°30′	175°00′W	24	6.6	6	13	5	1	..	25
14	July 10	50°22′	177°45′W	24	6.9	6	66	1	5	..	78
15	July 12	50°59′	178°50′E	24	6.8	50	36	1	2	..	89
16	July 13	50°18′	177°28′E	24	6.7	11	19	1	5	..	36
17	July 14	49°39′	176°11′E	24	7.1	4	12	2	45	..	63
18	July 15	49°00′	175°00′E	24	7.2	14	17	2	11	..	44
19	July 16	50°00′	175°00′E	24	7.1	17	30	..	7	..	54
20	July 17	51°00′	175°00′E	24	7.2	7	18	..	15	..	40
21	July 18	52°00′	175°00′E	24	7.2	54	31	1	6	..	92
22	July 19	53°00′	175°00′E	24	8.6	2	139	..	3	..	144
23	July 20	53°15′	175°45′E	24	8.2	..	43	1	4	..	48
24	July 21	53°07′	176°55′E	24	8.0	4	162	2	6	..	174
25	July 22	53°00′	178°00′E	24	8.1	1	12	..	..	..	13
26	July 24	53°00′	179°48′E	24	7.2	..	129	2	1	..	132
27	July 25	53°00′	178°30′W	24	7.1	..	153	5	7	..	165
28	July 26	53°00′	176°54′W	24	7.4	..	3	..	..	..	3
29	July 27	52°58′	175°13′W	24	7.9	7	82	2	4	1	96
30	July 28	52°22′	176°17′W	24	7.7	..	..	..	..	..	..
31	Aug. 5	51°30′	175°00′W	24	8.5	73	17	..	16	1	107
32	Aug. 6	50°00′	175°00′W	24	8.6	88	37	..	5	3	133
33	Aug. 7	49°00′	175°00′W	24	9.1	37	44	1	4	..	86
34	Aug. 9	49°00′	170°00′W	24	9.2	12	47	..	1	..	60
35	Aug. 10	50°00′	170°00′W	24	9.3	39	84	..	..	1	124
36	Aug. 11	51°00′	170°00′W	24	9.2	74	52	..	..	1	127
37	Aug. 15	52°51′	166°00′W	24	10.0	38	365	2	15	1	421
38	Aug. 19	54°07′	160°00′W	24	10.8	..	6	..	2	..	8
39	Aug. 20	53°30′	160°00′W	24	11.1	5	36	..	1	1	43
40	Aug. 25	49°43′	146°10′W	24	11.8	..	..	..	1	..	1
41	Aug. 27	51°30′	140°00′W	24	14.9	..	..	..	..	..	..
Total						736	2242	107	171	18	3274

1. Date hauled.

2. Temperature readings at time of set.

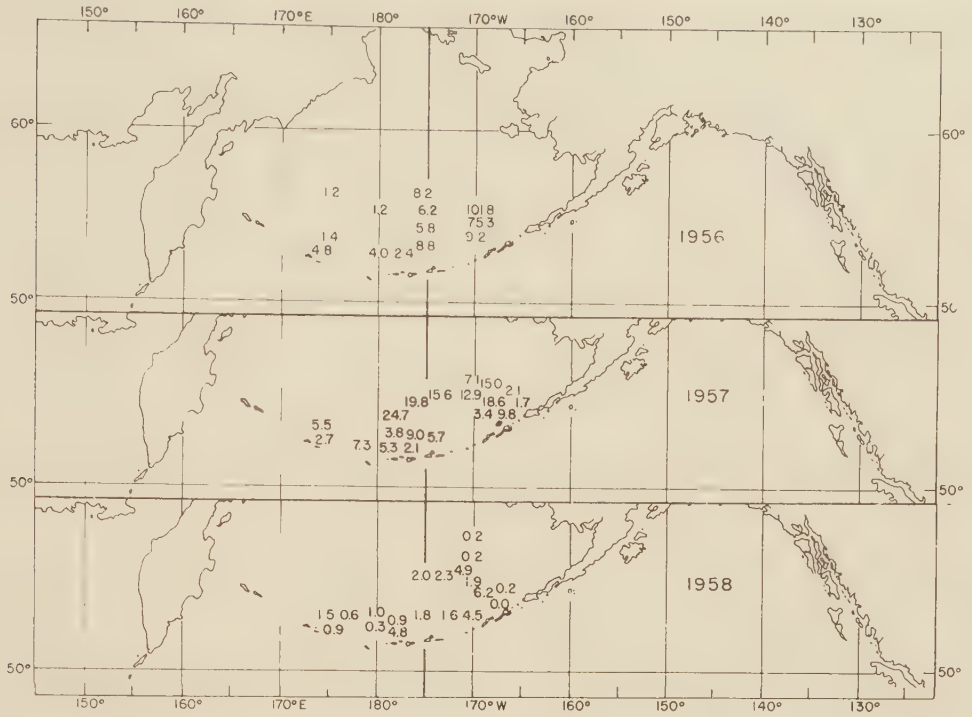


Figure 2. Catch of adult red salmon per hundred fathoms of net; Bering Sea, June 1 to 25, Japanese and U.S. research vessels.

The distribution of mature red salmon in the central and eastern Bering Sea areas during the period June 1 to 25, for years 1956 through 1958, is shown in Figure 2. Data for the central Bering Sea area (175°W. to 175°E.) are catches made from June 1 to 15 and for the eastern Bering Sea (170° W. and eastward) catches from June 16 to 25. The catches show the year to year fluctuation in the distribution and relative abundance of mature red salmon in the central and eastern Bering Sea during June.

In 1956 a large concentration of red salmon was encountered in the eastern Bering Sea at 170°W. No such concentration was discovered at this longitude in 1957, but catches in the central area were considerably higher. From our records it appears unlikely that any similar concentration of red salmon occurred north of the Aleutians in 1958.

In an effort to obtain an index of the size of Bristol Bay runs, the eastern Bering Sea area has been fished from June 16 to 25 during the three years (Figure 2). The largest catch per hundred fathoms of gear was 101.8 in 1956, 18.6 in 1957, and 6.2 in 1958. These and associated catches in this area, when compared to Bristol Bay red salmon pack data, apparently reflect the decreasing size of the Bristol Bay runs during the three years.

Pink salmon

The largest catch of pink salmon in 1958 was 30; only four sets captured more than 10. For comparison, in 1957 the largest single catch was 828. All data from 1955 through 1958 indicates the presence of more pinks in the odd numbered years.

Chum salmon

No marked change from previous years either in abundance or distribution is indicated for chum salmon. The largest catch occurred at 52°51′N.-166°W. on August 15. It included 365 chums of which only 5 per cent were in the juvenile size group (2 year old fish). As in 1957, juvenile chums again dominated July catches in the western Aleutians.

Silver and chinook salmon

Fewer silver and chinook than the reds and chums are captured in the central Aleutian area. They vary little in total numbers. In 1957, 75 sets by the MV *Pioneer* and MV *Attu* captured 164 silvers and 39 chinook. In 1958, 78 sets by the same vessels captured 175 silvers and 26 chinook.

Table 4 gives corrections for the material in Table 2 of the Annual Report for 1957.

Corrections: The material in Table 2 "Research for the United States" in the Annual Report for 1957 was in error. The following table corrects and supercedes that published in 1957.

Table 4. Salmon catches of United States research vessel MV *Attu*, May 28 - August 24, 1957.

Set No.	Date	Position Lat.	Position Long.	Temp.	Red	Chum	Silver	King	Pink	Total	Steel-head
1	May 28	50°00'N	175°W	5.9°C	7	34	..	..	99	140	..
2	May 30	50°00'N	175°W	5.9°C	8	62	..	..	118	188	..
3	May 31	50°00'N	175°W	5.8°C	6	21	..	..	252	279	..
4	June 8	53°00'N	175°W	5.8°C	52	1	..	5	68	126	..
5	June 9	53°00'N	175°W	5.6°C	58	10	..	5	78	151	..
6	June 10	53°00'N	175°W	5.7°C	68	14	..	1	62	145	..
7	June 15	56°00'N	175°W	5.8°C	237	14	..	1	61	313	..
8	June 17	56°00'N	173°W	6.9°C	187	16	..	2	174	379	..
9	June 18	56°00'N	170°W	7.4°C	116	9	..	1	11	137	..
10	June 19	56°52'N	170°W	7.0°C	68	1	..	..	....	69	..
11	June 20	56°00'N	170°W	7.7°C	9	1	..	..	2	12	..
12	June 21	56°00'N	168°W	7.9°C	63	6	..	..	20	89	..
13	June 22	55°00'N	168°W	7.9°C	88	5	..	..	9	102	..
14	June 23	56°00'N	166°W	9.1°C	19	1	..	..	....	20	..
15	June 24	55°00'N	166°W	9.5°C	15	10	..	..	5	30	..
16	July 8	56°00'N	165°W	10.4°C	2	..	..	..	....	2	..
17	July 9	56°00'N	165°W	10.2°C	1	..	..	..	....	1	..
18	July 10	56°00'N	165°W	10.6°C	20	8	..	..	....	28	..
19	July 15	54°00'N	160°W	11.9°C	66	90	1	2	12	171	6
20	July 17	52°00'N	160°W	10.2°C	109	38	1	4	....	152	3
21	July 19	50°00'N	160°W	10.3°C	8	90	4	1	1	104	3
22	July 21	50°00'N	165°W	10.0°C	3	55	2	1	....	61	2
23	July 24	53°00'N	165°W	11.0°C	123	253	4	..	2	382	10
24	July 25	53°40'N	165°W	10.1°C	15	35	2	..	29	81	..
25	July 27	56°00'N	165°W	10.1°C	3	2	8	..	1	14	..
26	July 27*	56°00'N	165°W	10.2°C	..	6	..	..	....	6	..
27	July 28	56°00'N	165°W	10.2°C	1	..	..	..	....	1	..
28	July 30	53°00'N	165°W	11.5°C	20	36	5	..	3	64	..
29	July 31	53°00'N	165°W	11.8°C	25	31	12	..	2	70	6
30	Aug. 9	50°00'N	165°W	11.4°C	16	163	..	..	....	179	4
31	Aug. 11	53°00'N	165°W	11.9°C	2	63	2	..	2	69	5
32	Aug. 14	54°30'N	166°W	10.4°C	1	..	1	..	....	2	..
33	Aug. 15	55°00'N	165°W	9.5°C	5	2	..	..	2	9	..
34	Aug. 16	53°00'N	165°W	12.8°C	14	247	8	..	....	269	15
35	Aug. 20	50°00'N	165°W	12.4°C	6	36	..	..	....	42	..
36	Aug. 21	50°00'N	165°W	12.5°C	2	6	..	..	....	8	..
37	Sept. 8	58°00'N	140°W	13.8°C	..	11	..	..	....	11	..
	Total				1443	1377	30	23	1013	3906	54

*Daytime set.

OCEANOGRAPHY

The purpose of the oceanographic observations is to define the oceanic environment of salmon and to relate the differences and fluctuations in the environment to the locations of the various stocks of salmon, their concentrations, and their migrations.

Field Work

Oceanographic observations in 1958 were taken aboard the charter fishing vessels MV *Pioneer* and MV *Attu* at various locations in the Gulf of Alaska, North Pacific Ocean, and Bering Sea from May 14 to August 30. A total of 183 stations were occupied; the locations are presented in Figure 3. Temperature, salinity and oxygen values were taken at various depths down to a maximum of 1050 meters. Vertical plankton hauls from 150 and 300 meters were made at 72 stations and midwater trawl hauls at 48 stations. A total of 394 BT traces were taken at and between hydrographic stations;

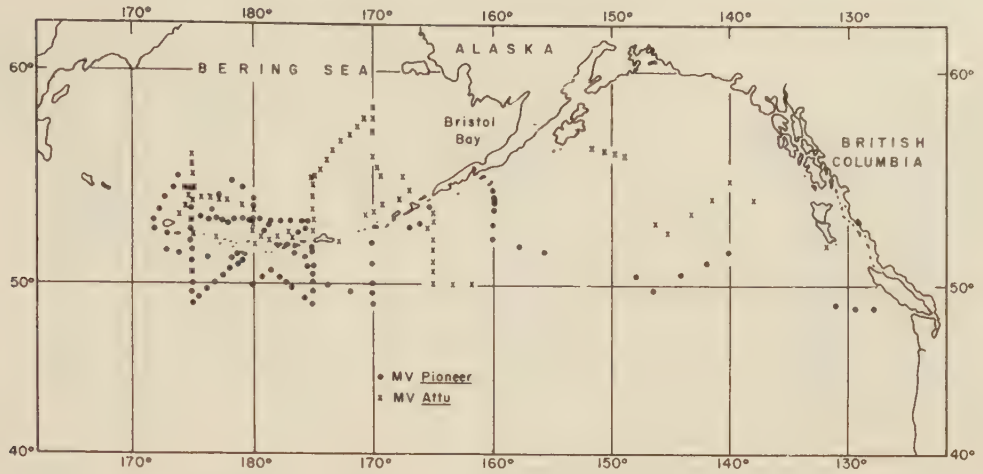


Figure 3. Oceanographic stations—May - August, 1958.

491 drift bottles were released at various locations along the Aleutian Chain.

A joint presentation of the 1958 data is in preparation, and therefore an analysis of these data is not included in this report except for comparison with other data.

Temperature

The 1957 cruise plans, designed to repeat observations at 50°, 53° and 56°N. along 165°W., 175°W. and 175°E. do not permit interpolation between meridians, but do provide an excellent time series of temperature changes at these longitudes. In Figure 4 the vertical profiles of temperatures along these longitudes in July clearly show continuity of the vertical tongue of warm water (4°C.) flowing out of the Gulf of Alaska along the Aleutian Chain, being held south at 165°W. by the shallow pass, protruding into the Bering Sea at 175°W., and being forced south at 175°E. by the cold Bering Sea water (3°C.). The figure also shows the pocket of warm surface water south of the chain at 165°W. and 175°W. which develops in late spring and early summer.

The development of this pocket is shown in Figure 5 which presents vertical profiles of temperatures at 175°W. in June, July and August. In June the warm surface waters from the Gulf of Alaska have not been moved this far west and no pocket is present. Its formation and subsequent thermal stratification are established in July and August, resulting in a surface temperature difference of about 2°C. between the Pacific Ocean and the Bering Sea. At depth, the intrusion south of the Chain of cold water from the Bering Sea is evident in June. This cold water receded northward in July, thus resulting in an intrusion of warm water north of the Chain; subsequent heating is shown in August by the 5°C. isotherm. The data collected are the first to show such complete continuity of the warm water flowing out of the Gulf of Alaska.

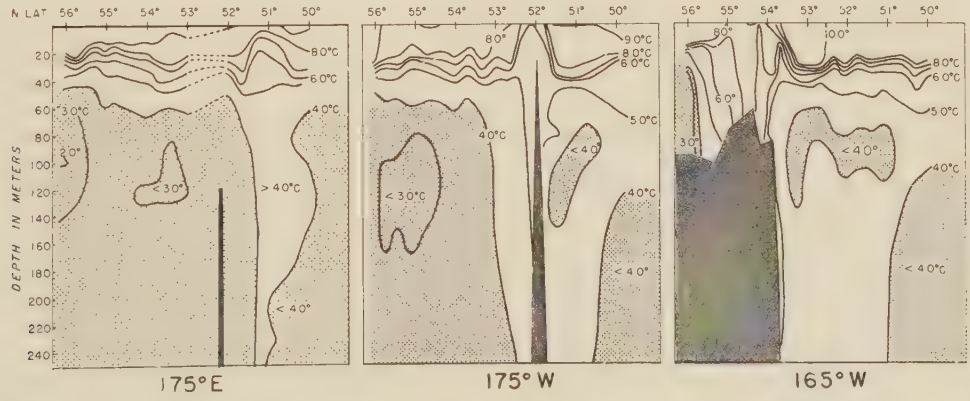


Figure 4. Vertical temperature profiles in July, 1957 across the Aleutian Chain.

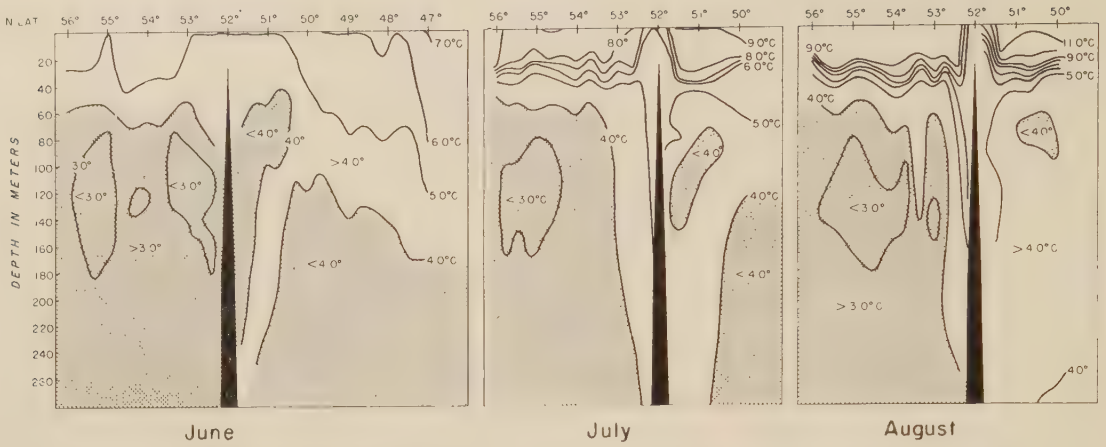


Figure 5. Vertical temperature profiles across the Aleutian Chain at 175°W. in 1957.

In 1958 the abnormally warm surface waters found along the American and Canadian coasts were present in May around the Gulf of Alaska as far west as 165°W.; however, this warming was not observed at 175°E. In May and June the surface water in the Bering Sea and south of the Aleutians was 1-2°C. colder than in 1957 and similar to conditions in 1956. Then, too, the vertical tongue of warm water isolated south of the Aleutians at 175°E. in 1957 as shown in Figure 4 was evident north and south of the Aleutian Chain at this longitude in 1958. The two conditions for July are shown in Figure 6.

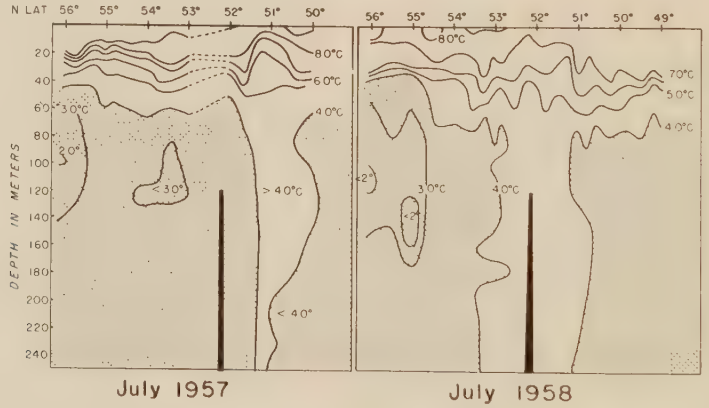


Figure 6. Vertical temperature profiles across the Aleutian Chain at 175°E.

Temperature-Salinity Relationships

The 1957 data also provided time series data of T-S (Temperature-Salinity) relationships at the locations of repeated observations. T-S curves are used to identify water masses, and deviations from standard curves show the relationship of specific curves to recognized water masses. Fluctuations in the curves at a single location indicate movement of water or frontal areas. Curves for the nine primary stations are shown in Figure 7. All are representative of Sub-Arctic water, except those at 56° N.-165°W. where the shallow depth prevents the formation of a characteristic curve.

The curves at 175°E. show at 50°N. and 56°N. only a gradual seasonal warming and dilution at the surface, whereas at 53°N., which is just north of the Aleutians, considerable fluctuations in the water properties at the surface and at depth are shown.

The curves at 50°N. and 53°N. at 175°W. also show a gradual increase in temperature and decrease in salinity at the surface with time, and slight gradients from 175°E. At 56°N.-175°W. the effects of progressive dilution from the Bristol Bay Shelf area are evident.

Along 165°W. the curves at 50°N. are similar to those at 50°N.-175°W. At 53°N. the effects of

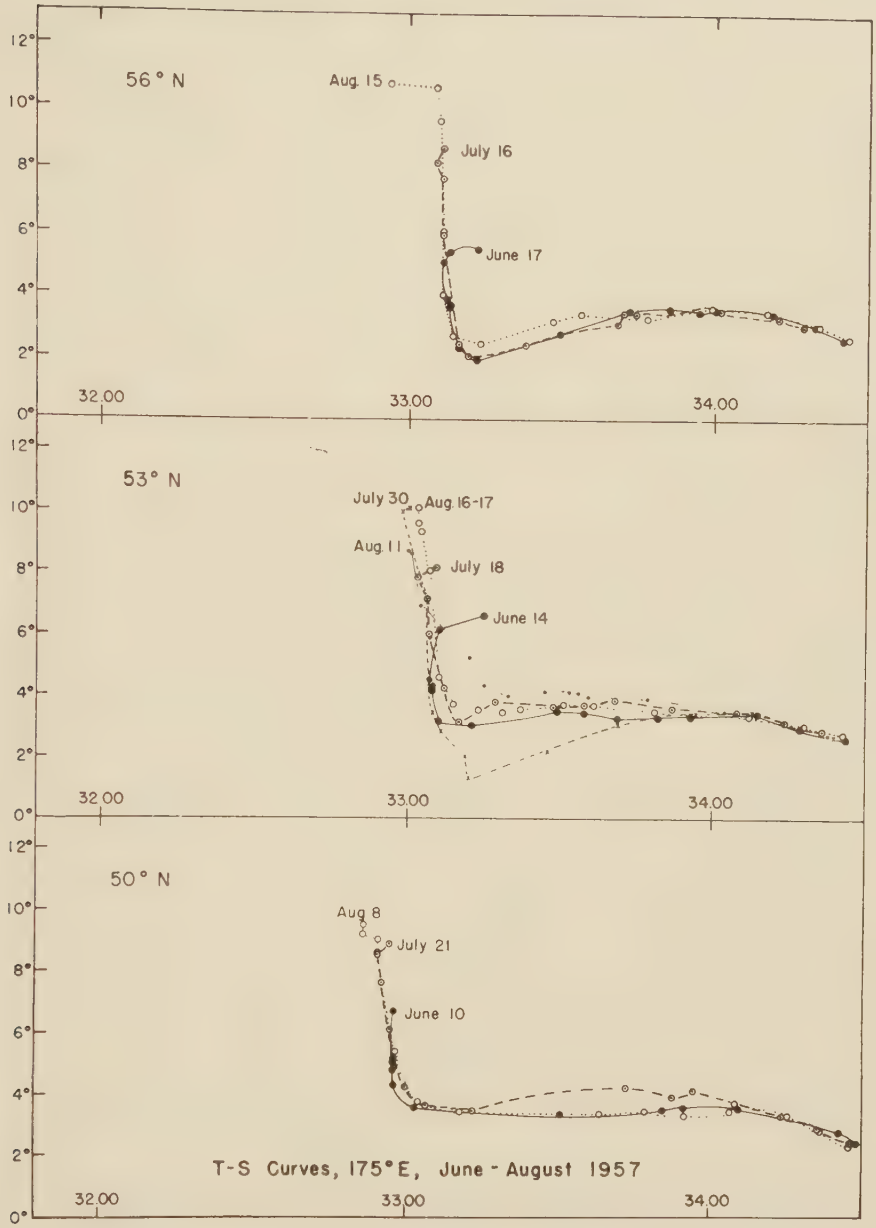


Figure 7a. Temperature-Salinity curves.

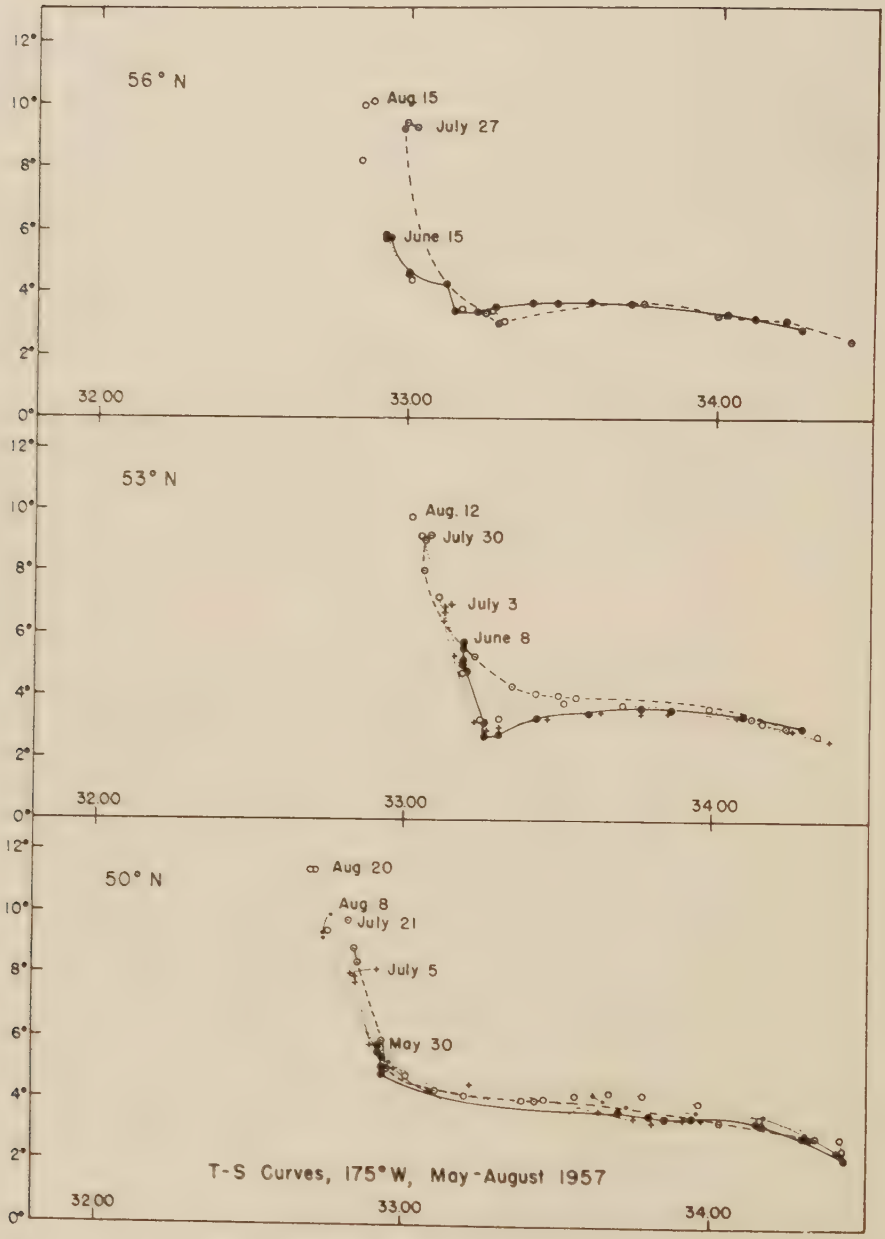


Figure 7b. Temperature-Salinity curves.

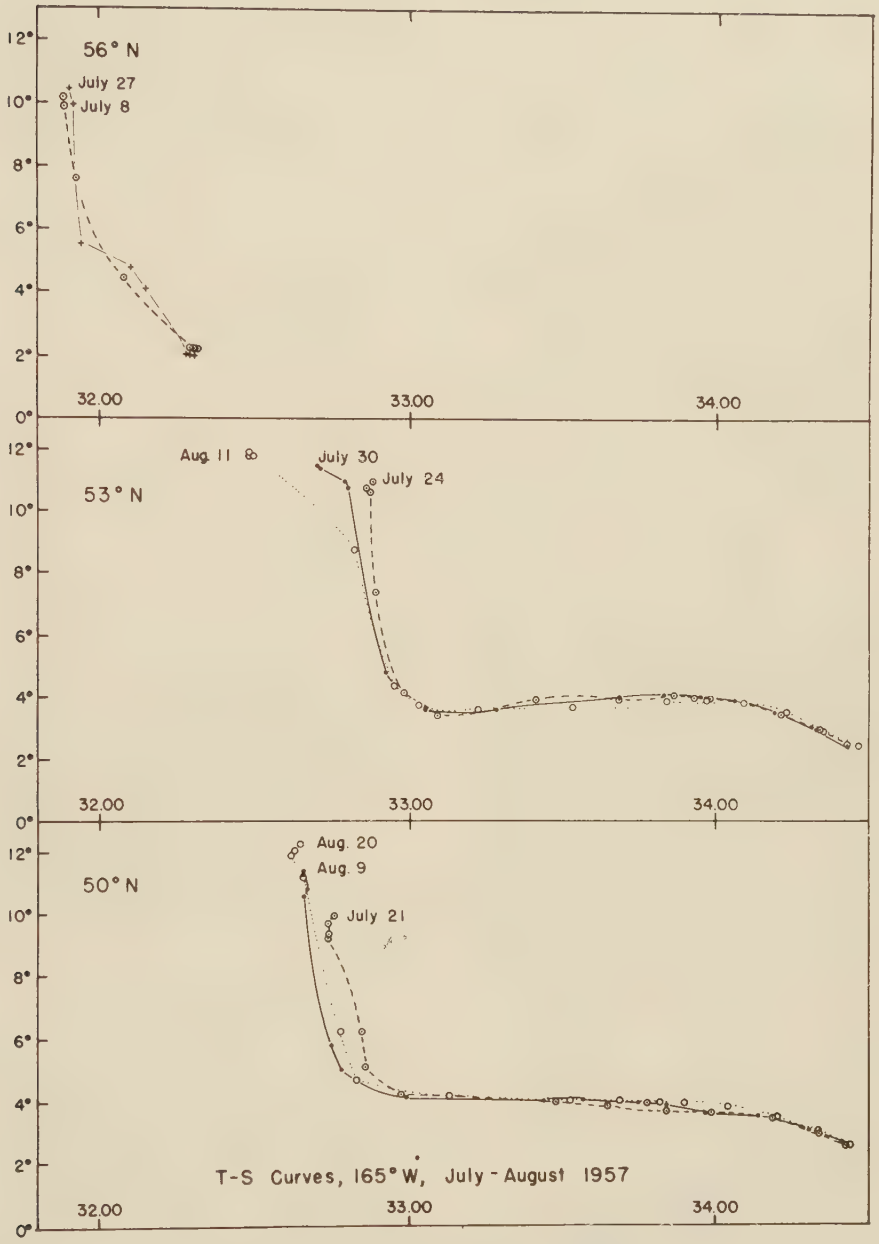


Figure 7c. Temperature-Salinity curves.

progressive heating and dilution by water flowing out of the Gulf of Alaska south of the Chain in July and August are apparent.

In order to show more clearly the effects of this dilution, associated with the previously described warm pocket and vertical tongue existing south of the Chain, stations in August on each of the three longitudes, but selected at particular latitudes, are shown in Figure 8. The curves are distinctly different from those characterized by the nine primary stations and show the source of heat and dilution advected into the Aleutian area during the summer.

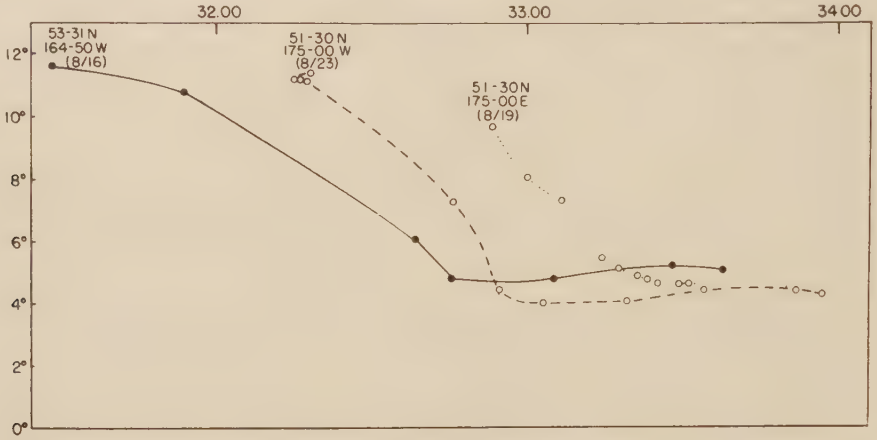


Figure 8. Temperature-Salinity curves at selected locations south of the Aleutian Chain, 1957.

Plankton

Plankton data collected in 1957 with ½-meter nets hauled from above and below the thermocline indicated the majority of the organisms caught in the Aleutian area were in the upper 30 meters. However, the number and size of organisms appear too small to support an appreciable nekton population. Therefore, in 1958, although 150 and 300 meter vertical hauls were made for comparative purposes, emphasis was placed on the use of a modified Isaacs-Kidd trawl, with an opening three feet in diameter, which was towed at three knots near the surface in the vicinity of the gill nets. The trawl catches have not been analyzed at this time. However, there is a marked similarity between the 1958 contours of plankton from the 150 meter hauls and the temperature contours at this depth. Figure 9 shows the wet weight in grams and Figure 10 the temperatures at 150 meters in July. The temperature data are more numerous than the plankton hauls because the latter are taken only at night to avoid some of the variations caused by diurnal migrations. The plankton data show only 2.5 grams in the frontal region at 50°N. with temperatures of about 3.5°C. The weight of plankton increases northward to over 20 grams in the Bering Sea where the cold temperatures encountered are not the result of a frontal region but due to winter cooling.

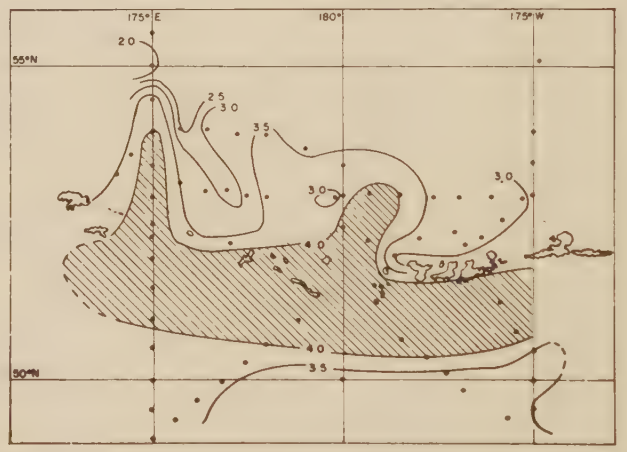


Figure 10. Temperatures (°C.) at 150 meters, July, 1958.

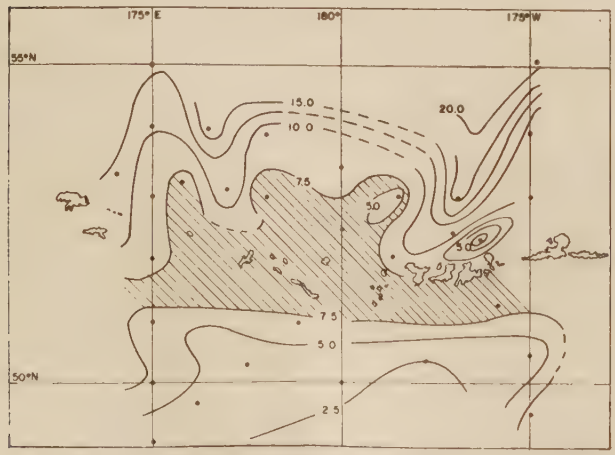


Figure 9. Wet weight (grms.) of plankton in vertical 150 meter haul, July, 1958.

Drift Bottles

Approximately five hundred bottles were released at various locations north and south of the Aleutian Chain in both 1957 and 1958. This is a very limited program as the usefulness of the drift bottle information is dependent upon early recovery of the bottles, and the sparse population in this area prevents such recovery. Figure 11 shows the release and recovery points of the bottle returns presented in Table 5. All were recovered ashore.

Table 5. Drift bottle results

Location	Released	Recovered
1	6/8/58	7/31/58
2	"	8/17/58
3	6/7/57	6/18/57
4	"	9/2/57
5	5/17/58	7/1/58
6	7/20/57	8/21/58...
7	"	9/21/58

Although few recoveries have been made at this time, they are significant. The northeast drift of bottles 1 and 2 indicates the probable terminus of the westward flow south of the Aleutian Chain in 1958 as indicated in Figure 11. Bottles 3, 4 and 5 show the general westward flow south of the Aleutians and the eastward return flow north of the Aleutians.

It is difficult to judge the extent of the eastward travel of bottles 6 and 7 and therefore the release and recovery points are connected by dashes. However, it is probable that they circulated around the Gulf of Alaska in less than a year.

Relationship to Salmon

Although the general salmon environment has been characterized as the Sub-Arctic water mass which we can easily identify, very little is known about the relationship of oceanographic conditions to abundance, distribution of stocks, and migration of salmon. Emphasis has been directed toward considering red salmon because of our ability to distinguish Asian and North American stocks.

Charter and tagging vessels have shown the presence of Bristol Bay mature and immature red salmon south of the Aleutians. The matures are present in spring and then appear to move west, turn northward through the passes, and return eastward to Bristol Bay. The immatures are present in the late summer.

The discussion of temperature and T-S relationships has shown the region south of the Aleutians to be a unique area oceanographically, and the presence of water originating from the North American coast, although modified by mixing, may affect the western distribution of North American salmon.

Figure 12 shows three locations of fishing stations occupied by the MV *Pioneer* in 1957 at which at least forty mature red salmon were caught. The dates are as follows: A - June 10, B - June 22,

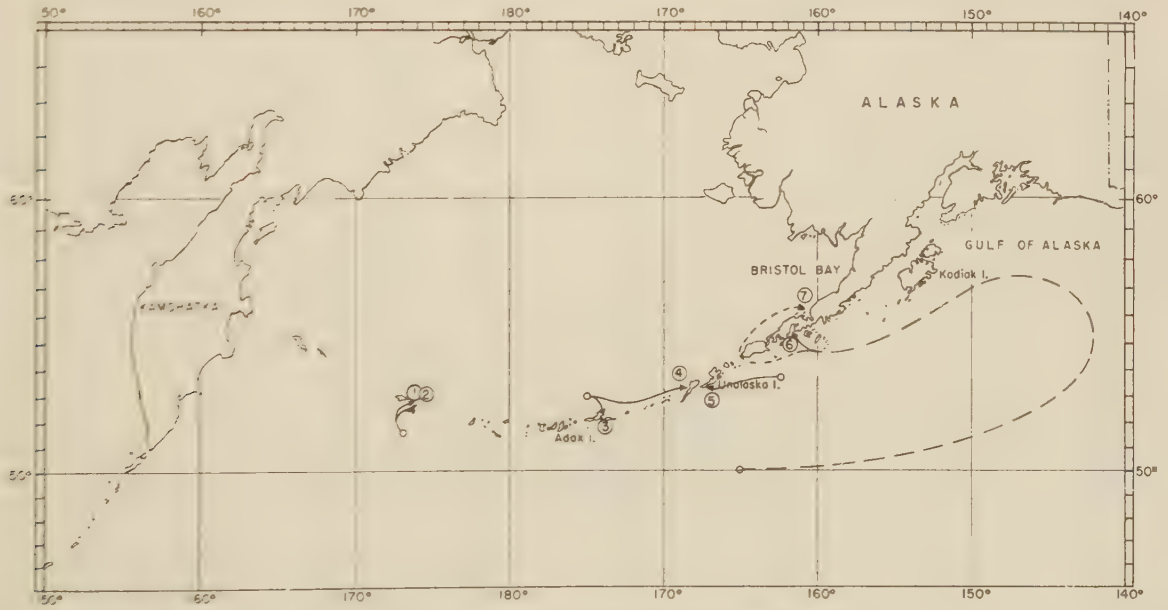


Figure 11. Drift bottle recoveries, 1957-1958.

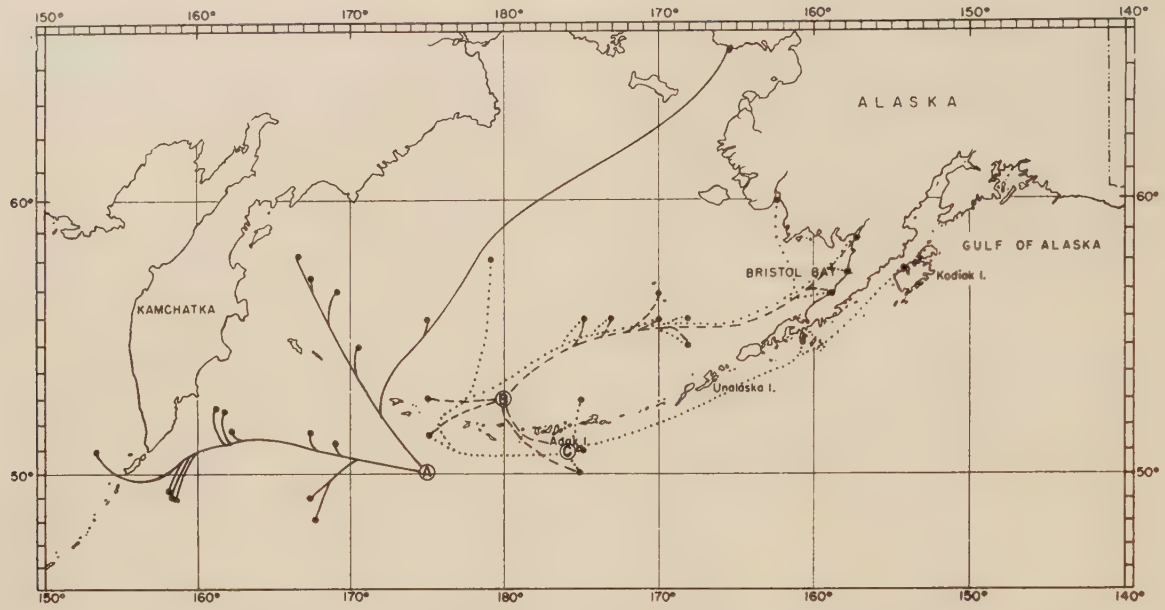


Figure 12. Relative identity of red salmon catches, 1957.

and C - July 8. The meristic characters of these fish were analyzed and compared to those of fish from 107 other sampling areas using the generalized distance function. Only those locations having a D^2 value less than .100 relative to stations A, B, and C have been plotted. The figure clearly shows the red salmon at Station A to be most similar to those caught between 175°E. and the Asian coast and those at Stations B and C most similar to those caught east of 175°E. and in Bristol Bay.

Figure 13 shows the temperature at a salinity value of 33.30 for the spring and summer, 1957. This salinity value has been chosen because it generally denotes the bottom of the surface layer and thus the depth of winter turnover. It is associated with the temperature minimum and exists at a depth that will maintain a reasonably constant temperature-salinity relationship. It also gives a better basis for comparison of the water north and south of the Chain and of the annual differences in

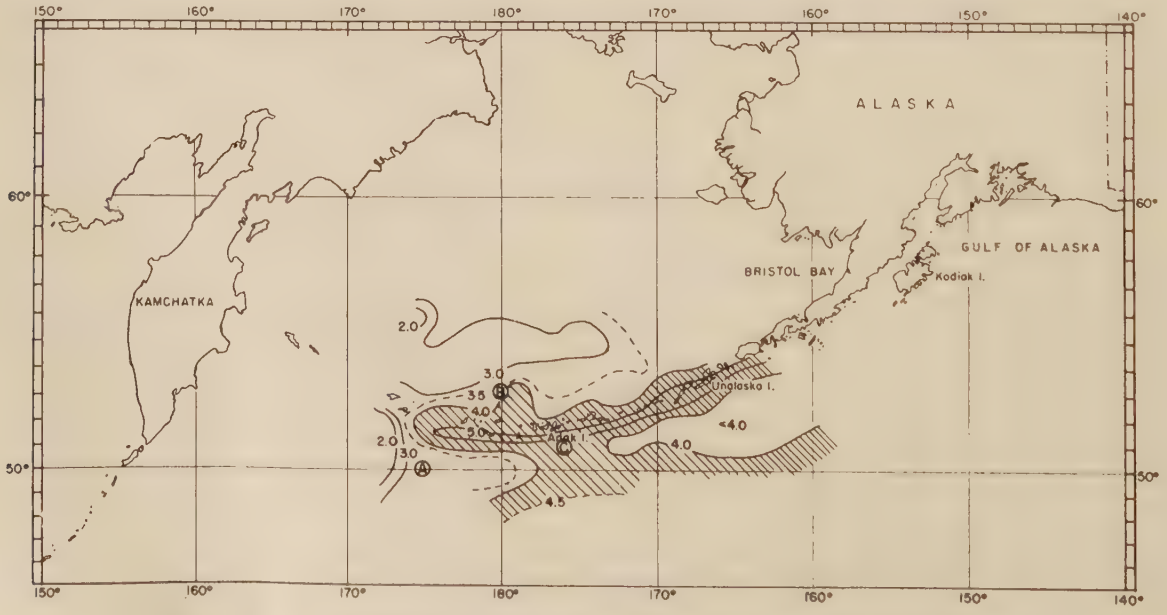


Figure 13. Temperatures (°C.) at salinity 33.30°/oo, Spring-Summer, 1957.

the Aleutian area. Station A is clearly within the region of the tongue of cold water intruding from the west which forms part of the Oyashio Gyral, whereas Stations B and C are associated with the warm water flowing out of the Gulf of Alaska.

Figure 14 shows the differences in the water structure for 1958. Although the tongue of the temperature minimum (4.0) protruding westward from the Gulf of Alaska in 1957 is absent, the area at 50°N. is considerably colder. Additional data from other sources will be required to define the extent of the eastward intrusion of the 3.5°C. tongue at 50°N.

Identification of the origin of fish in the 1958 catches will aid in determining the validity of using the frontal zone at the westward terminus of the Aleutian current as a criterion for separating stocks of Asian and North American red salmon.

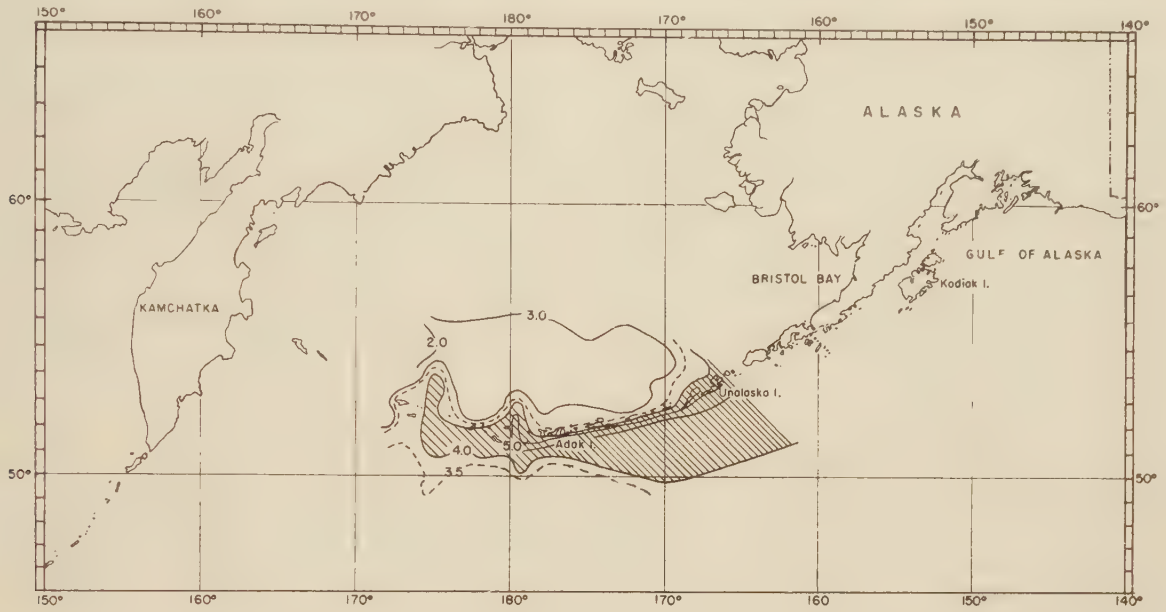


Figure 14. Temperatures (°C.) at salinity 33.30°/oo, Spring-Summer, 1958.

SALMON RACIAL SAMPLING

Our objective in racial sampling is to produce adequate, representative samples for the various racial investigations. To plan this, we consult with the several investigators and advisors to determine sampling areas, sample size, and other features of sampling.

To cover the geographic range of the three species of salmon (reds, chums and pinks) presently under intensive study, we request samples from the fisheries agencies and salmon industries of Japan and Canada through the Secretariat of the International North Pacific Fisheries Commission.

Our samples are obtained from the Columbia River northward to the Arctic Circle in North America; from the ocean research vessels of the three countries in the North Pacific Ocean and Bering Sea; from the Japanese mothership operations in the North Pacific Ocean and the Bering and Okhotsk Seas; and from the Japanese land-based fishery and river systems. Our coverage in 1958 along the Asian coastline extends from southern Hokkaido northward to Cape Olyutorski at 59°N. latitude. While samples from Siberia proper are still lacking, we are getting samples from areas adjoining Asia through the Japanese.

In Alaska a seasonal crew does the sampling, with the help of the U.S. Bureau of Commercial Fisheries Juneau Regional Office, the Fisheries Research Institute of the University of Washington and the Alaska Department of Fish and Game. In British Columbia the Fisheries Research Board of Canada and the International Pacific Salmon Fisheries Commission collect the samples. The Washington State Department of Fisheries and the Fish Commission of Oregon aid in obtaining samples from Washington and Oregon.

On the ocean research vessels, biologists from the Seattle Biological Laboratory of the U.S. Bureau of Commercial Fisheries, from the Fisheries Research Board of Canada and from the Japanese Fisheries Agency collect the samples. The Japanese mothership samples are collected by three different fleets, designated by the Japanese Fisheries Agency. The Hokkaido land-based fishery samples and stream samples were collected by Japan with the advice and assistance of Mr. L. M. Nakatsu, U.S.

biologist, who was stationed in Japan to co-ordinate the collection of samples from Japan in 1958.

Four types of samples are collected. They consist of (1) whole salmon, frozen for laboratory studies on morphology, parasites and scales, (2) blood samples for serology, (3) limited numbers of young downstream migrant salmon for comparison of racial characters with the adults and (4) field morphometric measurements and scales to augment the data taken in the laboratory.

The sample size for morphology in 1958 was reduced from that of former years to 125 red, 100 chum and 75 pink salmon per sampling station. Replicate samples at different times of the season were taken from certain areas. In addition, 25 red salmon per station were collected for use in the parasite studies by Canada. For the blood studies, the sample size in 1958 was expanded to 25 fish of each species from key stations, where in past years the sample size was 10 per station. Japan requested samples of 100 whole fish from certain Alaskan areas. In addition, downstream migrant salmon in sample sizes similar to the adult fish samples were requested by the three countries from certain areas.

Total collections of red, chum and pink salmon samples in 1958 for United States racial studies include 21,632 whole salmon (Table 6) and 2,319 blood samples (Table 7). Special collections for Japan include 200 reds, 100 chums and 100 pinks from Bristol Bay; 100 chums and 100 pinks from the Alaska Peninsula and 100 chums from the Kuskokwim River. For Canadian parasitological studies 591 red salmon from American coastal areas (Columbia River northward to the Seward Peninsula) were collected. Canada will also share with the United States the red salmon samples collected by the Japanese and United States research vessels.

The significant feature of the sampling in 1958 is the increase in the number of samples along the coastline of Kamchatka, Kurile Islands and Japan. These samples were obtained through the Japanese research vessels and land-based fishery (Tables 6 and 7). Another noteworthy feature is that more than 12,000 whole salmon (Table 6) and 1,300 blood samples (Table 7) were collected for United States

Table 6. Number of whole salmon specimens collected in 1958 for U.S. racial studies.

Source	West of 175°W. Longitude				East of 175°W. Longitude			
	Red	Chum	Pink	Total	Red	Chum	Pink	Total
Japanese inshore areas								
N. Hokkaido traps	..	200	200	400	..	..	..	..
N. Hokkaido streams	..	100	100	200	..	..	..	..
Japanese land-based fishery								
Japan Sea	..	..	100	100	..	..	..	..
Off E. Hokkaido	..	350	600	950	..	..	..	..
Off Kurile Is.	..	173	172	345	..	..	..	..
Japanese mothership fishery								
Okhotsk Sea	500	400	400	1300	..	..	..	..
N.W. Pacific Ocean	1494	1196	1099	3789	..	..	..	..
Japanese research vessels								
Off E. Kamchatka	348	295	260	903	..	..	..	..
Bering Sea	..	100	22	122	80	..	..	80
U. S. research vessels								
Bering Sea	212	2254	80	2546*	174	155	37	366
N. central Pacific Ocean	518	827	56	1401*	277	632	2	911
Canadian research vessels								
N.E. Pacific Ocean	..	..	..	..	709	419	117	1245
American coastal areas								
Alaska Peninsula	..	..	..	..	575	100	275	950
Bristol Bay	..	..	..	..	1295	102	100	1497
N. of Bristol Bay	..	..	..	..	123	349	150	622
Kodiak Island	..	..	..	..	355	100	200	655
Cook Inlet and Pr. Wm. Sound	..	..	..	..	223	100	150	473
Southeast Alaska	..	..	..	..	425	349	425	1199
British Columbia	..	..	..	..	625	400	450	1475
Puget Sound	..	..	..	..	..	103	..	103
Total	3072	5895	3089	12056	4861	2809	1906	9576

Grand totals

Red	Chum	Pink	Total
7933	8704	4995	21632

*Includes samples on 175° W. Long.

Table 7. Number of salmon blood samples collected in 1958 for U. S. racial studies

Source	West of 175°W. Longitude				East of 175°W. Longitude			
	Red	Chum	Pink	Total	Red	Chum	Pink	Total
Japanese inshore areas								
N. Hokkaido traps	..	25	17	42	..	..	..	..
N. Hokkaido streams	..	25	25	50	..	..	..	..
Japanese land-based fishery								
Japan Sea	..	..	25	25	..	..	..	..
Off E. Hokkaido	..	45	45	90	..	..	..	..
Off Kurile Is	..	19	20	39	..	..	..	..
Japanese mothership fishery								
Okhotsk Sea	69	49	50	168	..	..	..	..
N.W. Pacific Ocean	179	87	100	366	..	..	..	..
Japanese research vessels								
Off E. Kamchatka	70	70	25	165	..	..	..	..
Bering Sea	..	25	22	47	25	..	..	25
U. S. research vessels								
Bering Sea	47	113	4	164	32	19	..	51
N. central Pacific Ocean	118	55	3	176	53	35	..	88
Canadian research vessels								
N.E. Pacific Ocean	..	..	..	..	12	..	..	12
American coastal areas								
Alaska Peninsula	..	..	..	..	25	25	25	75
Bristol Bay	..	..	..	..	200	..	..	200
N. of Bristol Bay	..	..	..	..	27	30	..	57
Kodiak Island	..	..	..	..	75	..	..	75
Cook Inlet and Pr. Wm. Sound	..	..	..	..	46	16	53	115
Southeast Alaska	..	..	..	..	75	49	50	174
British Columbia	..	..	..	..	46*	..	..	46
Puget Sound	..	..	..	..	69	..	..	69
Total	483	513	336	1332	685	174	128	987

Grand Totals			
Red	Chum	Pink	Total
1168	687	464	2319

*An additional 20 red salmon blood samples collected from Adams River for Japan.

racial studies from the area bounded by the Provisional Line (175° West Longitude) in the east and Asia in the west.

STUDY OF SCALES

Biologists completed the scale readings of the 1957 red salmon in July 1958. Because of the increased number of areas sampled in 1957, more extensive studies have been required to evaluate the area of origin of the offshore fish.

Small samples of scales from red, pink and chum salmon from the Kamchatka Peninsula streams in 1957 were examined. Again as in 1956, the comparison of scale characters indicates that salmon from the Japanese samples off the southeast coast of Kamchatka and the Okhotsk Sea are essentially different from the salmon from North America. The differences are small when compared with some of the Aleutian Island areas such as Attu, but as a rule the farther the areas are separated geographically, the greater the differences between them.

A number of approaches to the problem of determination of racial origins were explored in 1958 using the data for the 1957 season: (1) the evaluation of the relation of the samples to each other by means of Generalized Distance Function, (2) the determination of origin of individual fish by means of a Discriminant Function based on the relation of samples found by Distance Function analysis and (3) the use of modified three-dimensional charts using the relation of two or more characters to each other.

Red Salmon Scales

The three dimensional charts are based on the fact that frequencies of certain scale characters for fish from Asian samples do not completely overlap those of fish from North America. For example, in the size of the total freshwater zone of red salmon scales from Bristol Bay which had spent two years in fresh water, 2 out of 401 were less than 18 mm. in projected length while for the Asiatic samples 108 out of 374 were less than 18 mm. When a 2 year freshwater fish with a freshwater zone less than 18 mm. in projected length is found offshore, it is most likely an Asian fish rather than a Bristol Bay fish. By relating one character to another for each freshwater age group, combinations

can be found which increase the amount of separation between the Asiatic and Bristol Bay area fish. By the use of a number of these relationships, most of the fish from the high seas can be keyed to their area of origin.

The preliminary results of these analyses were reported at the annual meeting of the INPFC in Tokyo. The distribution of American type red salmon as found by both the Discriminant Function Analysis and the frequency relationship charts was essentially the same, varying only in detail.

For May and June, 1957, almost all of the red salmon found in the Bering Sea samples out to about 180° were Bristol Bay type fish. Moving westward, the proportion of American fish decreased to almost completely Asian type fish at about 170°E. longitude. A somewhat higher proportion of Asian type fish was found south of the Aleutians. In the North Pacific, Asian type fish predominated to about 175°E. with a decreasing proportion of Asian types eastward to about 170°W.

For the season July to September 1957, similar results were found with somewhat higher percentages of American type fish in the area south of the Aleutians from the North American coast to at least 180°.

Studies are underway to evaluate the scale characters (1) which provide the greatest degree of separation and (2) which provide the greatest stability from year to year. The objective is to determine the best method for determination of racial origins of the individual fish.

Pink Salmon Scales

Determinations of the scale characters of the pink salmon were completed in September, 1958. Preliminary analysis was also reported at the annual meeting of the INPFC in Tokyo.

Generalized Distance Functions were used to compare the mainland with the offshore Aleutian area samples for 1955, 1956 and 1957. Although the 1957 high seas samples primarily contained fish of Asiatic origin, there were indications that some American fish from the Bering Sea coast of Alaska and the Aleutian Islands were present. Determinations were not made of the racial origins of the individual fish on scale characters alone since the samples of 1955 and 1956 were not complete enough to give reliable estimates, and a method had not yet been developed to our satisfaction to apply to the 1957 series.

Studies are currently under way to evaluate the characters and establish limits of their variability. The most definitive scale characters will be included with the best meristic characters into a combined analysis which will maximize the separation between the pink salmon of the various areas and provide the basis for identification of continental origin for individual fish.

PARASITES OF CHUM SALMON

The use of parasitological criteria for discrimination between groups of fish assumes the existence of significantly different rates or kinds of parasitism in the parent stocks. Wherever such differences can be demonstrated, it is then possible to examine samples of fish drawn from a potential mixing area and to make objective estimates of the degree of mixing by statistical comparison of the observed levels of infection with such expected levels as pre-determined from the parent stocks. In determining continental origin of chum salmon in high seas mixing areas, we have attempted to find parasitological criteria which would define Asian and North American types in general; the probability of identifying river races of chum salmon by means of parasites appears to be quite remote.

The qualitative findings in this study have been reported earlier. We have now reached the point where it is desirable to apply the differences in parasitic infestation as a means of distinguishing quantitatively the continental origin of chum salmon found on the high seas. The studies are confined to the nematode larva *Anisakis* sp., a form which occurs more or less regularly in salmon in tightly coiled cysts on surfaces of visceral organs and in the musculature. The other parasites used have shown little promise.

From the 1957 samples of chum salmon, 1,877 individual fish were examined. Quantitatively, this total represents a three-fold increase over the numbers examined from the 1956 fishery.

The average number of *Anisakis* per fish must differ between the Asian and North American standards for one to use this character in determining the origin of fish in offshore samples. The first requirement is a valid test of significance between these averages.

The frequency distributions of the number of parasites per fish from the sampling areas are, in general, highly skewed. The appropriate transformation is log (count+1), since the standard deviation is roughly proportional to the mean[1]. We find after transformation that the mean for pooled North American sub-areas is significantly lower than that for Asian sub-areas ($p<.01$). Thus we reject the general hypothesis that *Anisakis* can provide no discrimination.

The mere presence of significant differences is not meaningful in terms of the Protocol problem.

1. Barnes, H.: The use of transformations in marine biological statistics. J. Counseil Expl. Mer., vol. 18, No. 1, 1952.

We require, instead, relative abundance estimates relating offshore fish to areas of origin.

This means that if we are to provide an estimate of the fraction of North American (or Asiatic) fish in each offshore area we must assume:

1. The distribution of parasites in North American fish in an offshore area must be the same as the distribution of parasites in adult fish returning to North America.
2. The distribution of parasites in Asian fish in an offshore area must be the same as the distribution of parasites in adult fish returning to Asia.

In other words, we must assume that in offshore areas, the fish from each continent have infection frequencies identical, within sampling limits, to frequencies for their continent of origin.

The truth of these assumptions is difficult to demonstrate. For a particular year class (i.e., chum salmon which were 4 years old in 1957) there appears to be rather wide differences in the rate of infection within the fish from various streams from a single continent. The data are being studied to test the validity of the assumptions involved and to devise means of adjusting for deviations from these assumptions as required.

SEROLOGY

Introduction

As part of the Commission's research program on questions pertaining to the Protocol, U.S. research scientists are developing serological methods for determining the continental origin of salmon taken on the high seas. The application of these methods to racial problems in salmon is based on the capacity of specific serological reactions to distinguish animals of diverse genetic background.

Red Salmon Serology

During 1958 extensive isoimmunization experiments were conducted on over 200 red salmon of the Columbia River stock reared in salt water at the Deception Pass Marine Research Station of the Washington State Department of Fisheries. These experiments involve transfusing blood from one

Table 8. The antigenic differences between Alaskan and Asian red salmon

Area	Number lacking antigens I and II	Numbers with antigens I and/or II
Alaskan samples—1955 and 1956		
Bristol Bay and Kuskokwim	4	82
Karluk	1	27
Cook Inlet	0	18
Ketchikan	0	7
Sub-total	5	134
Alaskan samples—1957		
Kuskokwim	0	28
Bristol Bay	2	82
King Cove	0	10
Karluk and Red River	0	50
Cook Inlet	3	17
Prince William Sound	1	16
Southeastern Alaska	0	40
Sub-total	6	243
TOTAL	11	377
Per cent	2.8	97.2
Asian samples		
Okhotsk Sea, 1955-1956	31	0
Circa 50N 160E, 1957	21	2
TOTAL	52	2
Per cent	96.3	3.7

salmon to another of the same species. Differences in the antigenic composition of individuals, comparable to the blood group differences found in man and many animals, were demonstrated by the production of antibodies, which would agglutinate the blood cells of the donor fish, in thirty recipients. This indicates the same range of antigenic diversity is present in salmon as in other animals where these methods have been extensively used in problems of racial identity. This approach should prove valuable on further investigation.

Serum antigens designated I and II occured in 135 of 140 red salmon samples taken in Alaska in 1955 and 1956 but were absent from 31 red salmon samples taken in the Okhotsk Sea in the same year (1957 Annual Report). These results as well as the results of analysis of the 1957 American shore samples and the most westerly high seas sample supplied by the Japanese in 1957 are summarized in Table 8. Of the 442 samples, only 13 would have been misclassified as to continent of origin, an error of 3%.

An additional serum antigen detected by agar diffusion has been designated as group A. This antigen is very strongly correlated with sex and maturity (Table 9). A statistical test is not required to show that this character occurs with overwhelming frequency in mature females. Although there are several possible explanations for this, the most likely one is that the character is an egg protein being synthesized in the liver and transported through the serum to the ovaries. Data obtained with this antigen may prove useful in determining whether female salmon taken on the high seas will mature and spawn during the same season. Only about 0.02 ml. of serum is required to make the test and results can be obtained in less than 24 hours. This antigen has been found to occur in maturing female salmon of all species.

Blood samples taken by the American exploratory vessels the MV *Pioneer*, the MV *Attu* and the MV *Paragon* in 1957 were tested in 1958. Unfortunately, the freezing unit on the MV *Attu* failed and the majority of her samples proved unsuitable for this analysis; only the first samples taken by this vessel (from sets 4 and 7) which were obviously well preserved were considered. The results of tests for antigens I and II on these 1957 samples are presented in Table 10.

Table 9. The correlation of antigen A with sex and maturity in red salmon high seas samples, 1957.

	Number with Antigen A	Number without Antigen A
Females Gonads greater than 10 grams	139	17
Females Gonads less than 10 grams	1	45
Males	6	140

The samples are divided into two groups based on time, position and proportion of mature females (Table 10). The proportion of mature females was determined serologically. Group 1 consisted of samples taken between June 8 and July 16, from 50° to 56°N. latitude and from 175°W. to 175°E. longitude, and a few small catches taken later in the season at 53° to 56°N. and 175°W. to 175°E. The proportion of mature female red salmon in these samples, as determined serologically, varied significantly from 50 percent in only a single case. Since the proportions of individuals possessing antigens I and/or II do not differ significantly by chi square test between individual sets in this group, the samples were combined to obtain an overall average proportion of red salmon in this group of probable American origin. This proportion is 127 of 222 fish or 57.2 percent. The incidence of antigens I and/or II in this group is compared with that in the 1957 Alaskan red salmon samples, and in the Asian samples in Figure 15.

Group 2 consists of samples taken from July 21 to August 24. Only an occasional mature female was present (18 out of 220). This group of mainly immature reds was found from 50°N. to 51°30'N. latitude by the American exploratory vessels until August 11 after which it was found further to the north as well. The proportion of individuals possessing antigens I and/or II did not differ significantly by chi square test between individual sets and consequently were combined to obtain an overall proportion of 104/220 or 47.3 percent. This proportion is significantly different from the proportion in group 1 (chi square 4.39, 1 d.f.).

Table 10. The incidence of antigens I and/or II in red salmon samples taken by the American exploratory vessels in 1957.

Group	Vessel	Set	Date	Location	Proportion with antigens I and/or II	Percent
1.	MV *Pioneer*	1, 2, 3	June 10-12	50°N 175°E	29/55	54
	"	4, 5	June 14-20	53 N 175 E	17/30	57
	"	6	June 22	53 N 180	4/9	44
	"	7, 8	June 29-30	56 N 175 W	5/16	31
	"	9, 10	July 3- 4	53 N 175 W	2/5	40
	"	13	July 8	51 N 176 W	11/18	61
	"	14	July 16	56 N 175 E	2/4	50
	MV *Atu*	4	June 8	53 N 175 W	19/36	53
	"	7	June 15	56 N 175 W	20/31	65
	MV *Pioneer*	15, 18, 24	July 19-28	53-56 N 175 E	13/13	100
	MV *Paragon*	6, 7	July 27-28	56 N 175 W	2/2	100
	"	8	July 30	53 N 175 W	1/1	100
	"	15	Aug. 12	53 N 175 W	2/2	100
				Total	127/222	57.2
2.	MV *Pioneer*	17	July 22	50 N 175 E	3/3	100
	"	26-37	Aug. 8-24	50-56 N 175 E	24/45	53
	MV *Paragon*	2	July 21	50 N 175 W	2/5	40
	"	11, 12	Aug. 6- 7	51-30, 51 N 175 W	21/37	57
	"	13, 14	Aug. 8- 9	50 N 175 W	24/65	37
	"	19, 20	Aug. 17-18	53 N 175 W	1/2	50
	"	21, 24	Aug. 20-23	50, 51, 51-30N 175 W	29/64	45
				Total	104/220	47.3

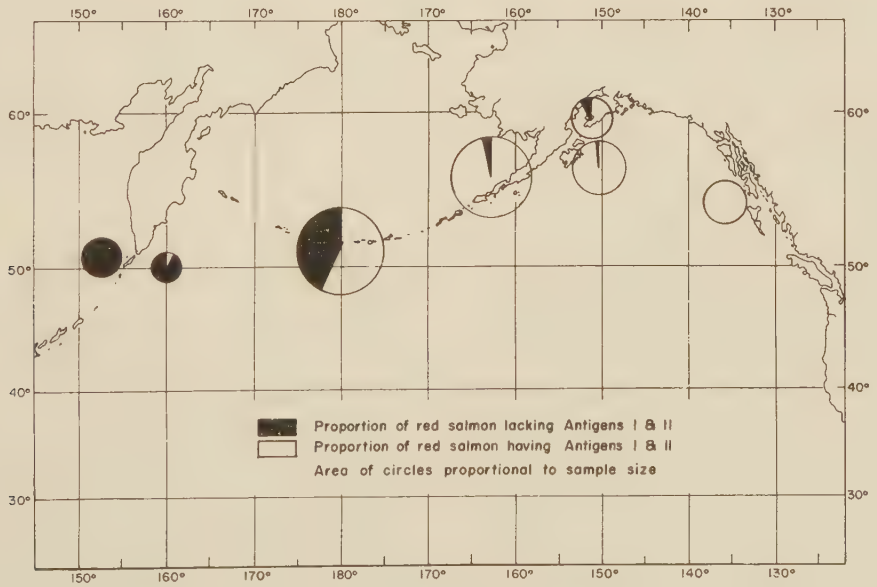


FIGURE 15. The incidence of antigens I and/or II in red salmon blood samples taken in 1955, 1956, 1957.

Table 11. The frequencies of pink salmon reacting strongly or weakly with several sera.

Serum	Pig 4		Pig 59		Bovine anti-sardine	
Class	Weak	Strong	Weak	Strong	Weak	Strong
Range of scores	3—7	8—12	8—11	12—16	4—7	8—12
AREA						
Cook Inlet	18	6	8	16	11	13
Prince William Sound	19	8	9	16	12	13
Ketchikan	24	1	12	13	8	17
Petersburg	12	13	12	13	2	23
Chi-square	14.8		1.78		17.8	

Pink Salmon Serology

A considerable amount of evidence has been obtained indicating that help in answering the questions raised by the Protocol can be expected from the application of serological methods to pink salmon. Individual differences in red blood cell antigens (blood groups) have been found to occur in pink salmon, and in some cases shown to differ significantly in frequency of occurrence between areas (Table 11). By use of the agar gel technique a soluble antigen has been discovered which differs significantly in frequency of occurrence between the pink salmon originating on the Asian and American continents (Table 12). The larger number of pink salmon blood samples obtained in 1958 will allow a more rigorous test of the antigen.

Table 12. The occurrence pink salmon soluble antigen 1 (PSA1) in 1957 samples from several areas.

Area	Date of collection	Number with PSA 1	Sample size	Percent with PSA 1
American shore stations				
Puget Sound	Sept. 6-23, 1957	23	24	96
Petersburg, Alaska	July 10, 1957	9	10	90
Ketchikan, Alaska	July 16, 1957	7	7	100
Sashin Creek, Alaska	August 28, 1957	6	8	75
Cordova, Alaska	August 3, 1957	5	10	50
Seldovia, Alaska	July 17	10	10	100
Kodiak, Alaska	August 2, 1957	10	11	91
King Cove, Alaska	July 20, 1957	9	10	90
	TOTAL	79	90	88
Asian samples				
50-52N 158-21E	June 13, 1957	4	10	40
Hokkaido (Tokoro Rv.)	Sept. 30, 1957	1	10	10
	TOTAL	5	20	25

ANALYSIS OF MORPHOLOGICAL DATA OBTAINED FROM THE RED, CHUM AND PINK SALMON COLLECTIONS

Red Salmon

The approach to morphological separation of the various "races" of red salmon is being developed along the following lines:

1. Determine the morphological characters which exhibit maximum variations between populations.
2. Ascertain the extent of these differences among red salmon populations of North America and Asia and evaluate the utility of these differences in identifying the continental origin of red salmon taken on the high seas.
3. Determine the extent of the variation in these characters within populations from year to year, between brood years, with advance in season or with age and sex of fish.
4. Ultimately by use of distance function and other multi-variate analytical techniques, classify fish taken at sea according to their natal streams by comparison of their morphological characteristics with those of reference areas of Asia and North America.

Specimens were collected from areas covering almost the entire geographic range of the red salmon. Sampling in the North American continent was sufficiently extensive to include all major fishery and escapement areas. Sampling of known Siberian stocks was again restricted to the Japanese commercial fishery in the Okhotsk Sea, but was supplemented by samples obtained from Japanese motherships which operated in the high seas areas of the Olyutorskii-Karaginskii regions. Systematic sampling by United States research vessels along predesignated longitudes and the comparative abundance of red salmon on the high seas in 1957 improved sampling of the North Pacific Ocean and Bering Sea.

Of twenty-three morphological characters obtained from each specimen, the eight listed in Table 13 were used in the distance function analysis. All enumeration of characters was from radiographs with the exception of the number of scales along the lateral line.

Table 13. Characters used in the generalized distance function anaylses of red salmon.

Character	Year 1955	1956	1957
Number of scales along lateral line	x	x	x
Positions of 1st complete haemal arch	x	x	x
Total number of gill rakers on 1st left gill arch	x	x	x
Number of branchiostegal rays on left side of head	x	x	x
Number of fin rays in left pectoral fin	x	x	x
Number of fin rays in anal fin	x	x	x
Number of caudal vertebrae		x	x
Number of gill rakers on ventral arm of 1st left gill arch		x	x

The Generalized Distance Function analysis (Mahalonobis, 1936; Rao, 1947; 1952) was used in the analysis of red salmon data. The statistic D, the Generalized Distance Function, is essentially a measure of the difference between two or more groups of data with each group consisting of one or more sets of variables. When D is zero there is complete similarity (100% overlap in the distribution curves of the variables) and when D equals four, the difference between means is quite distinct (4% overlap in the distribution curves). The application of this statistic requires normal (or near normal) distribution of variables and a common dispersion matrix (common variance and covariance). Frequency tables and diagrams of the morphological characters used are being carefully studied and to date no radical departures from normality or major differences in variance and covariance have been observed.

The interrelationships of the 1957 inshore samples of red salmon are very similar to those of 1955 and 1956. The relationships of a given area to the other areas sampled has remained relatively constant for the three years. A list of the samples used in the 1957 analysis is given in Table 14.

As in 1956, the high seas samples obtained from the Aleutian Island area most closely resembl-

Table 14. List of samples used in the generalized distance function analysis. 1957 red salmon

Sample No.	Locality	Date collected	Sample size
1	Naknek Weir	July 3	100
2	"	July 5	100
3	"	July 11	58
4	"	July 12	100
5	"	July 21	54
6	"	July 25	100
7	Egegik River	July 13	184
8	Ugashik River	July 19	186
9	Wood River	July 17	166
10	Kvichak River	July 9	96
11	Kvichak River	July 10	92
12	Okhotsk Sea 52°08′N 154°15′E	June 24	200
13	Okhotsk Sea 50°52′N 153°28′E	July 4	200
14	Okhotsk Sea 51°16′N 153°39′E	July 14	200
15	Karluk Weir spring run	June 20	95
16	Karluk Weir fall run	Aug. 21	110
17	"	Sept. 9	95
18	"	Sept. 17	120
19	Red River	June 21	199
20	Am. Hi. Seas MV *Attu* 53°N 175°W	June 8	52
21	" 53°01′N 175°03′W	June 9	58
22	" 53°N 175°W	June 10	44
23	" 56°N 175°W	June 15	201
24	" 56°N 173°W	June 17	151
25	" 56°N 170°W	June 18	89
26	" 56°52′N 170°W	June 19	67
27	" 56°N 168°W	June 21	62
28	" 55°N 168°W	June 22	87
29	Am. Hi. Seas MV *Pioneer* 50°N 175°E	June 10	43
30	" 50°N 175°E	June 11	64
31	" 50°N 175°E	June 12	65
32	" 53°N 175°E	June 20	61
33	" 53°N 180°	June 22	48
34	" 56°N 175°W	June 30	42
35	" 51°N 176°W	July 8	45
36	" 50°N 175°E	Aug. 8	41
37	" 53°N 175°E	Aug. 11	62
38	" 53°N 175°E	Aug. 12	86
39	" 56°N 175°E	Aug. 14	42
40	" 53°N 175°E	Aug. 17	91
41	" 53°N 175°E	Aug. 18	61
42	" 51°30′N 175°E	Aug. 19	149
43	" 50°N 175°E	Aug. 20	93
44	" 51°30′N 175°E	Aug. 23	107
45	Columbia River: Wenatchee River	Aug. 12	60
46	Columbia River: Okanogan	Aug. 14	49
47	Jap. Hi. Seas: Bering Sea, 58°15′N 179°10′E	June 27	59
48	" 58°10′N 177°17′E	July 1	42
49	" 54°51′N 170°24′E	July 6	40
50	" 57°02′N 169°11′E	July 12	35
51	" 57°26′N 167°27′E	July 13	32

Continued . . .

Table 14. (Continued from page 96)

Sample No.	Locality	Date collected	Sample size
52	" 58°12'N 166°48'E	July 15	60
53	Jap. Hi. Seas: East Kamchatka, 52°33'N 166°04'E	June 20	93
54	" 52°28'N 161°42'E	June 30	107
55	" 52°36'N 161°21'E	July 10	116
56	" 51°33'N 161°40'E	July 20	94
57	" 51°22'N 160°15'E	July 22	108
58	" 51°13'N 159°45'E	July 24	89
59	Nome; Salmon Lake	July 26	52
60	Kuskokwim River; Bethel	June 25	57
61	Kuskokwim River; Bethel	June 27	40
62	Fraser River; Gulf of Georgia	Aug. 1	73
63	Fraser River; Gulf of Georgia	Aug. 6	106
64	Skeena River	July 19	103
65	"	July 30	100
66	Chignik Weir	July 25	43
67	"	July 26	40
68	"	July 27	61
69	"	July 28	53
70	Petersburg	July 11	211
71	Nass River	July 4	97
72	Copper River	June 24	79
73	"	July 16	45
74	"	Aug. 1	75
75	Yakutat	Aug. 1	200
76	Ketchikan	Aug. 14	41
77	"	Aug. 15	43
78	"	Aug. 16	49
79	"	Aug. 17	41
80	Rivers Inlet	Aug. 12, 13	89
	Total		6,935

ed Okhotsk Sea or Bristol Bay in the morphological characters studied. Using these areas as the North American and Asian standards, the relative similarity of each high seas sample to these was determined.

Figures 16 and 17 show the areas from which samples were obtained and the D^2 values of these samples when compared to Bristol Bay and Okhotsk Sea for 1956 and 1957 respectively. It can be seen that the collections in the two years were not entirely comparable in time of sampling or in allocation of effort north and south of the Aleutian Islands. Sampling in the western Aleutian Island area in 1956 commenced May 25 whereas in 1957 the first sample from this area was not obtained until June 10. In 1956 more samples were obtained from the North Pacific Ocean than from the Bering Sea. The situation was reversed in 1957 with more samples obtained from the Bering Sea.

In 1957 a relatively marked variability in D^2 values occurred at 175°E. longitude (Figure 17). The variability is attributable to samples obtained in the North Pacific Ocean. Accordingly, for 1957 the Bering Sea and North Pacific Ocean were considered separately.

Bering Sea distribution. For 1956, samples obtained at stations 1 (June 20) and 2 (June 26) both resembled Bristol Bay (D^2=0.173 and 0.258) more closely than Okhotsk Sea (D^2=2.512 and 1.656 respectively).

In 1957, waters between 56°52'N. and the Aleutian Islands from 175°E. longitude to 165°W. longitude were sampled by United States research vessels. These vessels commenced fishing in the Bering Sea on June 8 (sample 20, Figure 18 and Table 14) and terminated operations in the Bering Sea on August 24, 1957. Sampling at 175°W. longitude and 175°E. longitude was repeated throughout the season. However, red salmon were taken in abundance in this area only during June and August. Therefore, only these samples were used in the analyses. With but two exceptions, stations

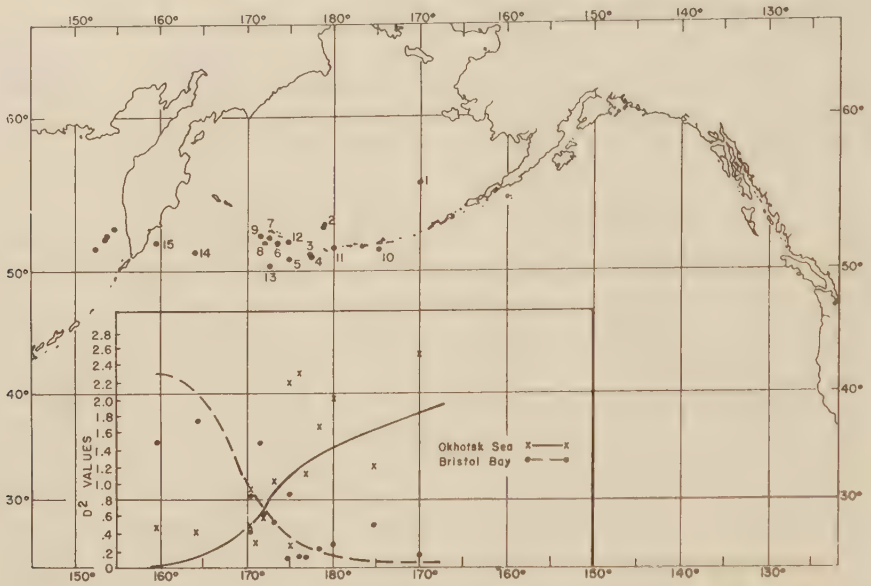


Figure 16. Location of high seas red salmon samples and their D^2 relationships to Okhotsk Sea and Bristol Bay, 1956.

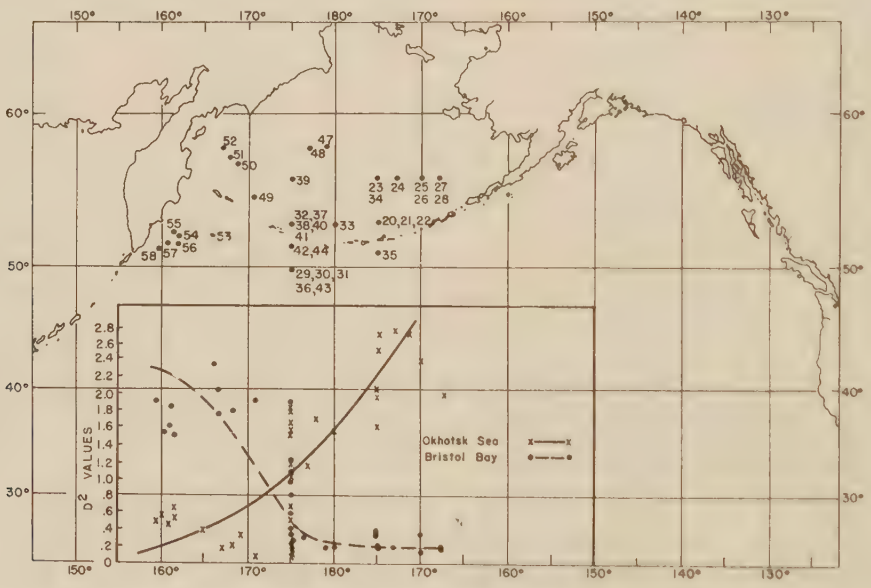


Figure 17. Location of high seas red salmon samples and their D^2 relationships to Okhotsk Sea and Bristol Bay, 1957.

32 and 39 (June 20 and August 14), samples taken east of 175°E. longitude resembled very closely red salmon of Bristol Bay. The average D^2 value of these samples when referred to Bristol Bay was 0.236.

The first samples obtained from the Japanese fishery in the area around 180° were collected on June 27 at 58°15′N. - 179°01′E. and July 1 at 58°10′N. - 177°17′E. Both these samples had morphological characters very similar to Bristol Bay reds with D^2 values of 0.176 and 0.326 as compared with D^2 values of 1.693 and 1.168 when referred to Okhotsk Sea reds or D^2 values of 1.251 and 0.744 when referred to the Olyutorskii samples.

Samples of red salmon taken by the Japanese mothership fishery after July 5 west of 175°E. longitude resembled more closely Asiatic salmon than they resembled North American fish.

Thus from the data at hand, regardless of time during the sampling period, in the Bering Sea, red

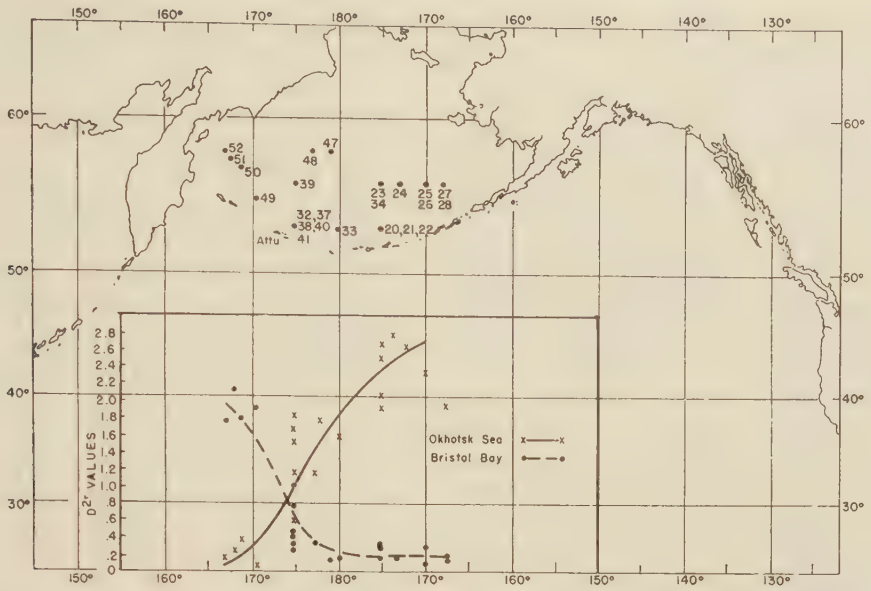


Figure 18. Locations of Bering Sea red salmon samples and their D^2 relationships to Okhotsk Sea and Bristol Bay, 1957.

salmon of Bristol Bay morphological type appeared to predominate in all samples taken as far west as 175°E. longitude. Similarity of samples to Bristol Bay type discontinued rather abruptly between 175° E. and 170°E. longitude. West of 170°E. red salmon with Asian characteristics predominated.

North Pacific distribution. Samples in 1956 from the North Pacific Ocean were most numerous between 180° and 170°E. longitude (Figure 16). Samples taken at stations 3 and 4 on May 25 and May 28, and those taken at stations 6 and 8 on June 5 resemble Bristol Bay more closely than Okhotsk Sea. Ten days later in the area between 170°E. and 175°E. longitude the resemblance to Bristol Bay of samples from stations 7 and 8 diminishes. The sample collected at station 13 on July 6 is relatively dissimilar to Bristol Bay (D^2=1.472) and similar to Okhotsk Sea (D^2=0.307). Similar relationships with Okhotsk Sea and Bristol Bay persisted with all samples taken west of 170°E. longitude. It is interesting to note that in August, immature red salmon of Bristol Bay morphological

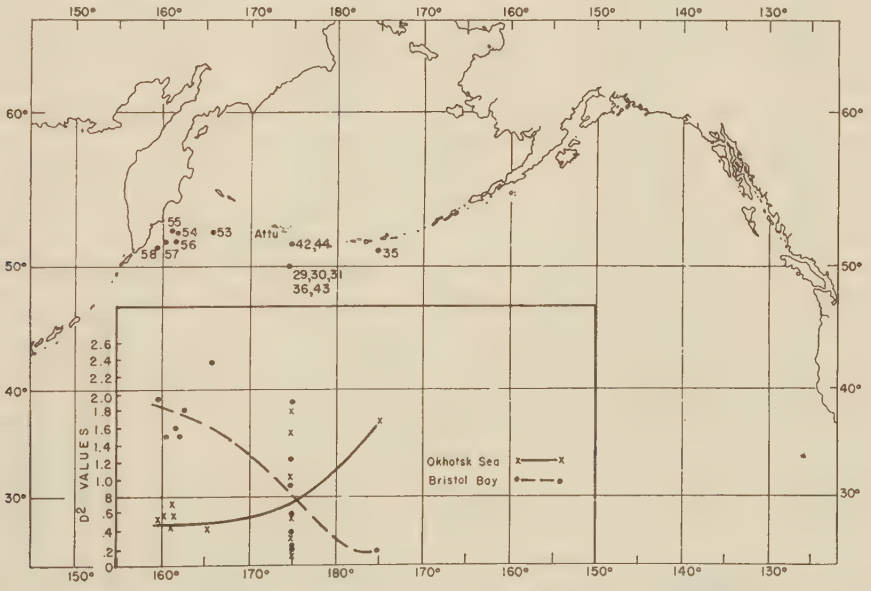


Figure 19. Location of North Pacific Ocean red salmon samples and their D^2 relationships to Okhotsk Sea and Bristol Bay, 1957.

type (D^2=0.133) were taken as far west as 175°E. longitude (station 12, Figure 16).

In 1957, sampling south of the Aleutian Islands at 175°E. longitude commenced June 10 and was terminated on August 23. Coverage in time of waters south of the Aleutians at 175°W. longitude was not as comprehensive as that in the Bering Sea at this longitude. Figure 19 shows sampling stations in the North Pacific Ocean and the relationships of their D^2 values with respect to samples from Okhotsk Sea and Bristol Bay. The one sample taken at 176°W. longitude (station 35, Figure 19) on July 8 morphologically resembled Bristol Bay samples (D^2=0.163).

At 175°E. longitude considerable variability in D^2 values was observed. Samples obtained by United States research vessels at this longitude on June 10, 11, 12 and August 8 (stations 29, 30, 31 and 36), exhibit morphological characters very similar to those of Okhotsk Sea fish (D^2=0.093, 0.193, 0.311 and 0.520 respectively). However, at this same longitude (stations 42, 43 and 44) in August, immature red salmon having morphological characters very similar to Bristol Bay red salmon were taken (D^2=0.157, 0.349, 0.159). A like occurrence of immature red salmon morphologically similar to the Bristol Bay type was seen in the western Aleutian area in August 1956.

Japanese mothership samples obtained from waters west of 170°E. longitude (stations 53 through 58, Figure 19) between June 20 and July 24 were similar to Okhotsk Sea red salmon (D^2=0.396 to 0.627) and quite dissimilar to red salmon of Bristol Bay (D^2=1.499 to 2.374).

Although data from stations south of the Aleutian Islands for 1957 are admittedly sparse, results of these analyses indicate that in general from mid-June through July red salmon of Okhotsk Sea type were taken as far east as 175°E. longitude.

In August immature red salmon of Bristol Bay type were found as far west as 175°E. longitude.

Chum Salmon

The chum salmon studies are being developed along lines similar to those for red salmon.

To provide a basis for identifying high seas fish, in 1956 specimens were collected from the principal chum salmon fisheries of North America. Sampling of known Siberian stocks was restricted to the Japanese commercial fishery in the Okhotsk Sea. In 1957, samples from the Okhotsk Sea were supplemented by samples obtained from Japanese motherships which operated in the high seas areas of the Olyutorskii-Karaginskii region. Five samples from Hokkaido (three from the land-based fishery and two from rivers) further supplemented the Asian collections. The positions at which samples were obtained in 1957 for the analyses are listed in Table 15 and plotted in Figure 20.

The characters used in the Generalized Distance Function analysis of chum salmon are shown in Table 16. The utility of some of the characters used with 1955 samples was re-examined and as a result some were discarded and replaced with more useful variables in the 1957 samples.

The majority of the 1957 high seas samples most closely resembled either the Okhotsk Sea group (Asian standard) or samples from Kodiak, King Cove, Kotzebue, and Teller.

An arbitrary classification of these high seas samples was attempted on basis of the D^2 values. The results (Figure 20) indicate that Asian chum salmon may be present, south of the Aleutian chain,

Figure 20. Location and classification of 1957 chum salmon samples based on relative values of D^2.

Table 15. 1957 chum salmon samples used in distance function analysis.

Area No.	Area	Sub-area	Date	Sample size
1	Puget Sound	Quilcene	Dec. 12	21
2	Petersburg	Seymour Canal	July 22-23	134
3	Hokkaido Is.	Abashiri fishery	Oct. 19	100
4	"	Tokoro fishery	Oct. 8	69
5	"	Shari fishery	Oct. 8-11	100
6	MV *Pioneer*	53N 180	June 22	55
7	Okhotsk Sea	52-08N 154-15E	June 24	135
8	"	51-16N 153-39E	July 14	135
9	Hokkaido Is.	Yubetsu River	Oct. 16	35
10	E. Kamchatka	51-13N 159-45E	July 24	66
11	"	52-28N 161-42E	June 30	67
12	"	52-33N 166-04E	June 20	68
13	"	52-36N 161-21E	July 10	65
14	"	51-39N 161-40E	July 20	66
15	"	51-22N 160-15E	July 22	68
16	Okhotsk Sea	50-52N 153-28E	July 4	135
17	Bering Sea	58-15N 179-10E	June 27	34
18	"	58-10N 177-17E	July 1	14
19	"	54-51N 170-24E	July 6	56
20	"	57-02N 169-11E	July 12	35
21	"	57-26N 167-27E	July 13	11
22	"	58-12N 166-48E	July 15	32
23	E. Kamchatka	49-14N 158-11E	July 10	35
24	"	49-02N 158-20E	July 14	25
25	King Cove	Shumagin Is. fishery	July 21	70
26	Kotzebue Sound		July 23	30
27	"		July 24	13
28	Yakutat	East R. fishery	Aug. 19-22	130
29	Fraser R.	River mouth	Oct. 15-16	100
30	King Cove	Shumagin Is. fishery	July 26	54
31	Hokkaido Is.	Abashiri River	Oct. 18	90
32	Cook Inlet	Rocky Bay	July 11	124
33	Kuskokwim R.	Bethel	June 25	54
34	"	"	June 26	18
36	Columbia R.	Astoria	Oct.	30
37	Kodiak Is.	Uyak Bay trap	July 30	124
38	Yukon R.	Old Andreafsky	July 1	135
39	Teller	Port Clarence	July 12	17
40	"	"	July 13	17
41	"	"	July 15	51
43	Puget Sound	Possession Sound	Oct.	50
44	Yukon R.	Alakanuk	July 4-5	125
45	MV *Pioneer*	54N 175E	July 25	45
46	"	50N 175W	July 7	106
47	"	50N 175E	July 21	50
48	"	50N 175E	July 22	42
49	MV *Attu*	54N 160W	July 15	79
50	"	53N 165W	July 24	100
51	"	53-40N 165W	July 25	30
52	"	50N 165W	Aug. 9	40
54	MV *Pioneer*	56N 175W	June 29	36
55	"	56N 175E	July 16	40
56	"	55N 175E	July 26	34
57	"	56N 175E	July 27	34
58	"	53N 175E	Aug. 17	126
59	E. Kamchatka	51-40N 167-27E	June 28	28
60	"	51-39N 162-16E	July 1	30
61	"	51-28N 161-15E	July 5	29
62	"	48-57N 158-30E	July 15	24
63	*Etsuzan Maru*	51-28N 169-55E	May 27	75
64	MV *Pionner*	53N 175E	July 19	109

Table 16. Characters used in the generalized distance function analyses of chum salmon, 1955 and 1957.

	Character	Year 1955	1957
1	Hypural plate-mideye length*	x	x
2	Number of scales along lateral line	x	x
3	Rows of scales below the lateral line		x
4	Total number of vertebrae		x
5	Number of caudal vertebrae	x	
6	Number of gill rakers on ventral arm of first left gill arch	x	
7	Total number of gill rakers on first left gill arch		x
8	Number of branchiostegals on left side of head	x	x
9	Number of pectoral fin rays	x	x
10	Number of dorsal fin rays	x	
11	Number circuli in second winter zone	x	

* Used only to adjust each character for correlation with length. When D^2 is computed the variable length is omitted.

as far east as 50°N. - 165°W. (sample 52). Sample 54 taken at 56°N. - 175°W. was intermediate in resemblance to the two groups. Data obtained from samples taken in this area which are yet to be analyzed will aid in determining if this is an area of intermingling of the respective continental stocks.

The samples in Figure 20 classified as undetermined do not closely resemble either the North American or Asian standards but are comparatively more similar to the Okhotsk Sea group which was used as the Asian standard. This seems to indicate that there may be populations not represented in our present Asian standard which contribute significantly to catches of chum salmon on the high seas.

High seas sample 49 most closely resembles the Cook Inlet standard; sample 50, Kotzebue standard; and sample 51, the Petersburg or Kotzebue chum salmon samples.

The results of morphological analyses of chum salmon to date are incomplete, particularly with respect to the extent of distribution of stocks from Asia and North America, for only a minor part of the samples obtained from the high seas have been examined. Furthermore, an increase in definition between certain North American and Asian reference populations is desirable and can probably be attained by use of scale characters.

Pink Salmon

Before 1957, identification of continental origin was based on specimens collected from the principal pink salmon fisheries of North America and the Japanese commercial fishery in the Okhotsk Sea. In 1957, samples from the Okhotsk Sea were supplemented by samples obtained from Japanese motherships operating in the Olyutorskii-Karaginskii region and from Hokkaido.

Of the twenty morphological characters obtained from each specimen, we have used only the six listed in Table 17 in the Distance Function analysis.

Table 17. Characters used in the generalized distance function analyses of pink salmon.

Character	Year 1955	1956	1957
Hypural plate-mideye length*	x	x	x
Position of 1st complete haemal arch	x	x	x
Number of branchiostegal rays on left side of head	x	x	x
Number of fin rays in left pectoral fin	x	x	x
Number of caudal vertebrae	x	x	x
Number of gill rakers on ventral arm of 1st left gill arch	x	x	x
Number of dorsal fin rays	x	x	x

* Used only to adjust each character for correlation with length. When D^2 is computed the length is omitted.

Table 18. List of areas — 1955 pink salmon samples.

Cluster No.	Area		Date	Sample size
1	Petersburg	(Taku Inlet)	July 7	20
		(Tenakee)	July 12	20
		(Port Houghton)	July 25	21
		(Farragut Bay)	Aug. 1	21
		(Stikine)	Aug. 9	21
		(Stikine)	Aug. 15	23
	Ketchikan	(Nelson Cove, Anan Cr., Burroughs Bay)	July 20	26
		(Burroughs Bay Clarence Str.)	July 28	25
		(Boca de Quadra, Foggy Bay, Smeaton Bay)	Aug. 5	25
		(Boca de Quadra, Pt. Eaton)	Aug. 12	25
	Skeena River		Aug. 25	26
			Aug. 4	25
			Aug. 11	24
			Aug. 18	25
	Skeena River	(Lakelse Lake)	Sept. 14	25
		(Lakelse Lake)	Oct. 3	26
2	Petersburg	(Windham Bay)	July 18	20
		(Cape Addington)	Aug. 22	23
3	King Cove	(Pavlov and Volcano Bays)	Aug. 2	11
		(Unga Strait)	Aug. 2	15
4	King Cove	(Unga Strait)	July 6, 7	39
		(Shumagin Is.)	June 27-29	25
		(Cold Bay)	July 19	11
5	Unalaska Is.	(Unalaska Cr.)	Aug. 17	36
	Attu Is.	(Gravel Pit)	July-Aug.	79
6	High Seas	(51-22N, 154-00E) Okhotsk Sea	June 30	20
		(51-46N, 154-04E) "		
		(53-25N, 153-50E) "	July 10	20
		(52-42N, 154-12E) "	July 20	23
		(52-02N, 154-30E) "	July 30	20
		(52-03N, 154-20E) "	Aug. 10	20
		(51-33N, 159-04E) E. Kamchatka	July 14	25
		(49-48N, 156-50E) "	July 27	15
		(48-36N, 157-27E) "	Aug. 10	17
		(52-48N, 161-02E) "	July 13	17
		(50-18N, 158-52E) "	July 30	17
		(53-29N, 163-21E) "	July 13	16
		(53-15N, 161-10E) "	July 27	25
		(50-13N, 161-57E) "	Aug. 10	25
		(48-33N, 165-30E) W. Aleutians	June 1	14
		(48-32N, 167-50E) "	June 1	25
		(48-35N, 168-36E) "	June 1	17
		(48-43N, 170-23E) "	May 18	16
		(49-40N, 169-11E) "	June 22	25
		(49-18N, 167-49E) "	June 22	24
		(48-45N, 168-00E) "	June 23	17
7	Ketchikan	(Nelson Cove, S. Kendrick Bay, Pt. Adams)	Aug. 19	25
		(Kasaan Bay)	Aug. 24	25
8	LaConnor		Aug.-Sept.	74

To depict the results of analyses for three years Figures 21 (Table 18), 22 (Table 19) and 23 (Table 20) were prepared. Each figure illustrates the morphological relationship of the sampled areas, similarity between fish of the various areas being inversely proportional to the distance between them. A table of sampling areas accompanies each figure.

A pink salmon analysis of any one year will involve only fish of the same brood year due to the particular life history of this species. Yearly variation, if present, will only affect the stability of the differences obtained between areas from year to year.

For the three years, 1955, 1956 and 1957, the morphological relationships of the inshore areas to each other have remained relatively constant. However, three years of sampling may not be sufficient to depict truly the degree of variation which can occur in each area with respect to all the other areas.

The high seas pink salmon samples obtained in 1955 and 1956 were from the Japanese mothership fishery in the western North Pacific Ocean and the Bering Sea. These samples resembled most closely samples of Asian type (Okhotsk Sea).

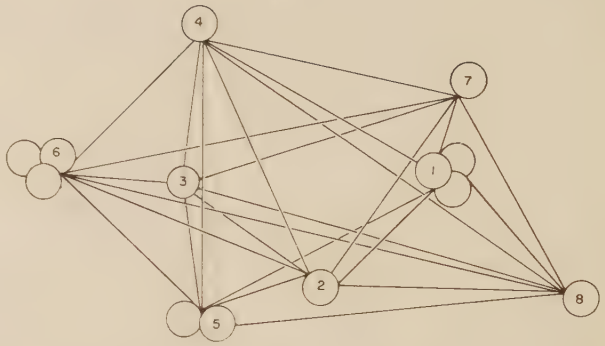


Figure 21. Generalized distance chart for 1955 pink salmon samples. See Table 18 for area identification.

1955 analysis. The pink salmon chart (Figure 21) shows that differences between groups exist with respect to the characters used. The high seas samples of pink salmon analyzed in 1955 are from the Japanese mothership fishery. Because of the lack of Asian shore samples, we used those from the Okhotsk Sea area (cluster 6) to represent the Asian type. The high seas samples from the East Kamchatka area and the West Aleutians area are morphologically very similar to the Okhotsk Sea

Table 19. List of areas — 1956 pink salmon samples.

Cluster No.	Area	Date	Sample size
1	Petersburg (Windham Bay)	July 19	96
	Skeena River (Lakelse Lake, Williams Creek)	Nov. 26	51
2	Seldovia (Ninilchik)	July 11	98
3	Kodiak Island (Karluk Weir)	Aug. 22	95
4	King Cove (fishery)	July 18, 20	163
	Unalaska Island (Shaisnikoff River)	Aug. 11	45
	Adak Island (Finger Bay)	Aug.	214
5	Unalaska Island (Humpy Cove)	Aug. 10	67
6	Unalaska Island (Margaret Bay)	July	168
	(Nanteeken River)	Aug. 23	49
	Attu Island (Lake Nicholas)	Aug.-Sep.	43
7	Unalakleet	July 9	100
8	Attu Island (Gravel Pit)	Aug.-Sep.	126
9	High Seas (51-55N, 154-13E) Okhotsk Sea	July 6	53
	" (51-49N, 154-06E) Okhotsk Sea	June 21	54
	" (51-56N, 172-30E) Jap. mothership	June 15	49
10	High Seas (52-08N, 154-32E) Okhotsk Sea	June 28	65
	" (51-22N, 153-51E) Okhotsk Sea	July 13	110
11	High Seas (46-40N, 166-29E) Jap. mothership	July 15	62
	" (49-21N, 159-23E) Jap. mothership	Aug. 5	84
12	Ketchikan (Anan Bay)	Aug. 7	59
	Rivers Inlet	Oct.	99
	Skeena River	Oct. 26	71
	Port John	Oct.	50
13	Nass River	Oct. 26	100
14	Yakutat	Aug. 20	55

Table 20. List of areas — 1957 pink salmon samples.

Cluster No.		Date	Sample size
1	Petersburg (Windham Bay)	Aug. 8	111
2	Seldovia (Tutka Bay)	July 4	100
3	Kodiak Island (Uyak Bay)	July 30	101
	King Cove (Shumagin Is.)	July 26	30
4	Unalakleet	July 9	96
5	King Cove (Shumagin Is.)	July 11	70
6	Attu Is. (Gravel Pit)	July-Aug.	127
	Attu Is. (Lake Nicholas)	July-Aug.	29
7	Attu Is. (Lake Cornica)	Aug.	56
8	High Seas (57-02N, 169-11E) Bering Sea	July 12	38
	" (58-12N, 166-48E) Bering Sea	July 15	29
9	High Seas (52-08N, 154-15E) Okhotsk Sea	June 24	92
	" (50-52N, 153-28E) Okhotsk Sea	July 4	90
	" (51-16N, 153-39E) Okhotsk Sea	July 14	90
10	Hokkaido Is. (Yubetsu River)	Sept.-Oct.	100
	" (Shari fishery)	Sept.-Oct.	63
	" (Tokoro fishery)	Sept.-Oct.	70
	" (Abashiri fishery)	Sept.-Oct.	64
11	High Seas (12 mi. S. of Atka) MV *Commander*	July 6	48
	" (53-00N, 175-00E) MV *Pioneer*	June 14	113
	" (49-13N, 169-00E) *Kano Maru*	May 24	23
	" (58-10N, 177-17E) Jap. mothership	July 1	29
	" (57-26N, 167-27E) Jap. mothership	July 13	32
	" (51-39N, 162-16E) Jap. mothership	July 1	35
	" (49-02N. 167-25E) *Etsuzan Maru*	May 31	86
	" (53-00N, 175-00W) MV *Attu*	June 9	85
12	High Seas (6 mi. S. of Little Tanaga) MV *Commander*	June 8	60
	" (8 mi. S. of Adak) MV *Commander*	June 20	51
	" (56-00N, 175-00E) MV *Pioneer*	June 29	113
	" (49-37N, 171-00E) *Kano Maru*	June 1	36
	" (51-40N, 167-27E) Jap. mothership	June 28	35
	" (53-00N, 175-00W) MV *Attu*	June 10	44
13	High Seas (50-05N, 179-56E) *Kano Maru*	June 8	53
	" (49-14N, 158-11E) Jap. mothership	July 10	35
	" (48-57N, 158-30E) "	July 15	98
	" (52-33N, 166-04E) "	June 20	50
	" (62-36N, 161-21E) "	July 10	67
	" (51-39N, 161-40E) "	July 20	54
	" (51-22N, 160-15E) "	July 22	68
	" (53-00N, 175-00W) MV *Attu*	June 8	64
14	High Seas (58-15N, 179-10E) Jap. mothership	June 27	23
	" (52-28N, 161-42E) "	June 30	67
15	High Seas (51-39N, 162-16E) "	July 1	35
	" (49-02N, 158-20E) "	July 14	35
	" (50-03N, 166-47E) *Etsuzan Maru*	June 1	87
16	High Seas (50-00N, 175-00E) MV *Pioneer*	June 10	99
17	High Seas (54-51N, 170-24E) Jap. mothership	July 6	27
18	High Seas (51-13N, 159-45E) "	July 24	49
19	Nass River (Sommerville)	Aug. 4	93
20	Fraser River (Gulf of Georgia)	Sept. 4	100
21	Skeena River (Tyee)	July 30	96

type and therefore are in the same cluster (cluster 6). The LaConnor, Washington; Canadian and Southeastern Alaska samples (clusters 1, 2, 7, 8) least resemble the Asian samples as indicated by their terminal positions in the figure. Samples from Unalaska, Attu, and King Cove (clusters 3, 4, 5) are morphologically intermediate.

1956 analysis. The morphological relationships in the 1956 chart (Figure 22) are very similar to those of 1955, the Okhotsk Sea samples (clusters 9, 10) at one extreme and the Canadian and Southeastern Alaskan samples (clusters 1, 12, 13) at the other. The samples from Unalaska, Attu, and King Cove (clusters 4, 5, 6, 8) are again intermediate as are the new sampling areas of Adak, Kodiak and Yakutat (clusters 3, 4, 14). Two new areas, Unalakleet and Seldovia (clusters 7, 2) have the same general values as the Okhotsk Sea which in 1956

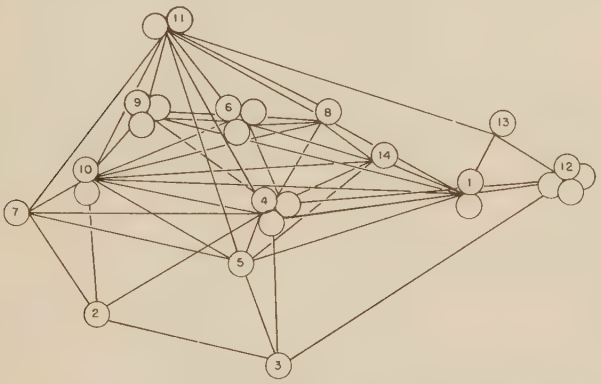


Figure 22. Generalized distance chart for 1956 pink salmon samples. See Table 19 for area identification.

divided into two clusters (9, 10). The high seas samples obtained in 1956 are again from the Japanese mothership and all resembled the Asian standard, Okhotsk Sea pink salmon.

1957 analysis. The 1957 pink salmon analysis (Figure 23) shows that in general, the relationships of the inshore areas have remained unchanged from those of 1955 and 1956. The samples from the Canadian areas are most dissimilar from those of Western Alaska and Asia as evidenced by their extreme positions in the diagram. The largest difference is between Fraser River (cluster 20) and Unalakleet (cluster 4), the D^2 value of 5.339 indicating almost complete morphological dissimilarity between these areas.

All of the high seas samples (clusters 8, 11, 12, 13, 14, 15, 16, 17, 18) closely resemble the Okhotsk Sea type (cluster 9) as well as Unalakleet (cluster 4), Attu Island (clusters 6, 7) and King Cove (cluster 5). The latter three areas have occupied positions near the Okhotsk Sea group in both the 1955 and 1956 charts.

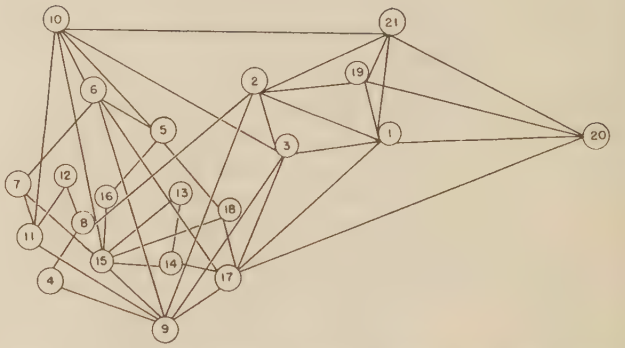


Figure 23. Generalized distance chart for 1957 pink salmon samples. See Table 20 for area identification.

In 1957 one King Cove sample resembled the Seldovia sample while the other resembled those from Attu Island. Samples from this area should more properly be considered as akin to the high seas samples and are probably composed of fish from the Aleutian Islands or the Alaska Peninsula.

Although large numbers of pink salmon were encountered widely on the high seas during 1957, no unusually large runs were reported from North American areas. Pink salmon samples taken south of the Aleutian Islands clustered with those taken by the Japanese motherships in the Olyutorskii-Karaginskii region (cluster 8) and with Unalakleet (cluster 4).

The preponderance of evidence would thus seem to indicate that most of the pink salmon in the Bering Sea and North Pacific Ocean as far east as 175°W. in 1957 were of Asian origin.

STUDY OF MOVEMENTS BY TAGGING

The purse seiners MV *California Rose*, MV *Commander* and MV *Renown* were again chartered by the Fisheries Research Institute for the 1958 tagging work.

The MV *Renown* left Seattle April 24 and returned September 2. Since the MV *Renown*'s primary assignment was to tag salmon far to the west, she operated mostly north, south, and west of Attu Island. In addition, she operated south of the Adak Group late in the season when large numbers of immatures were located there.

The MV *Commander* left Seattle May 8 and also returned September 2. She fished between Adak and Attu in late May and early June, then worked northward from Adak as far as St. Matthew Island and returned to the Pribilof Islands area in late June. Following this, she fished south of Umnak and Unalaska and finally fished westward again to finish the season in the Attu Island area.

The MV *California Rose* departed Seattle June 8 and returned September 20. During June, the

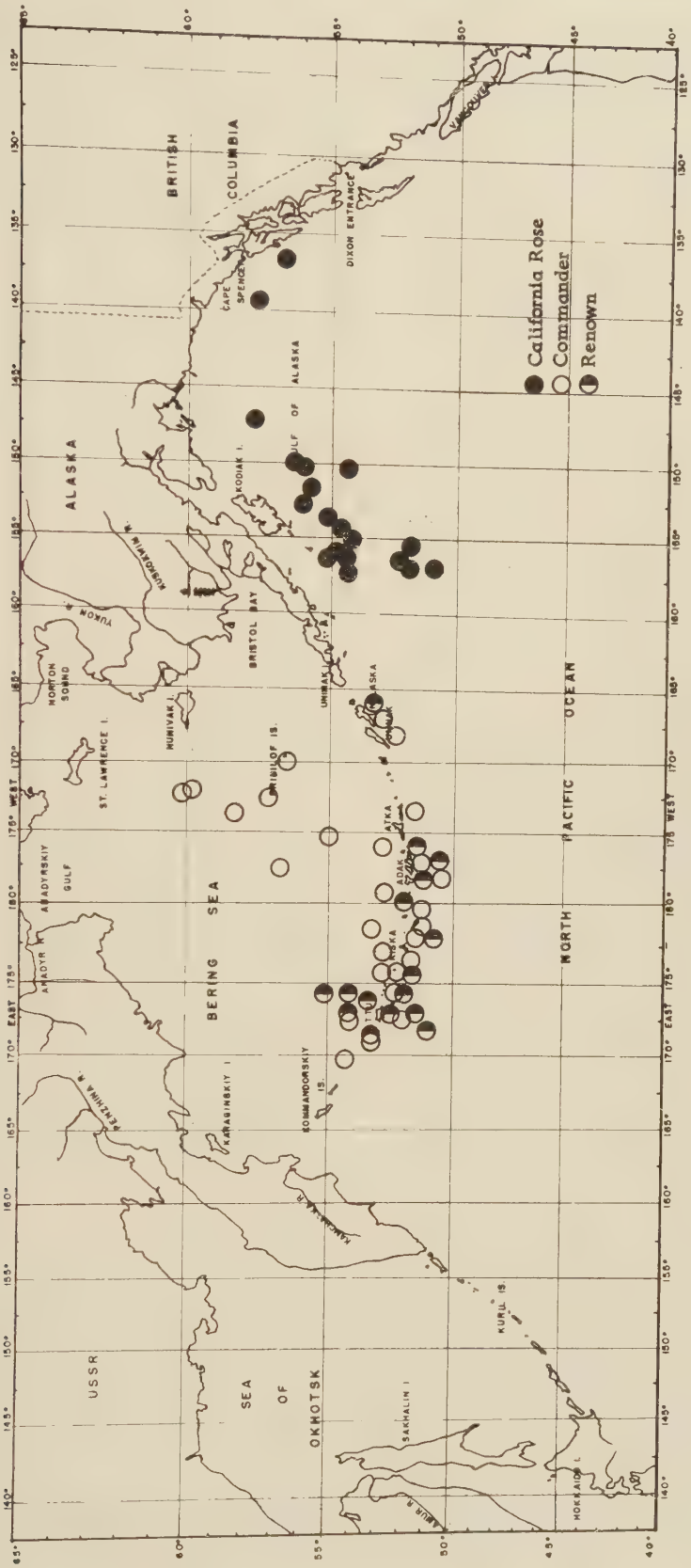


Figure 24. Tagging Locations - 1958.

MV *California Rose* tagged in the Gulf of Alaska and offshore south of Kodiak Island. From June 27 to July 16 she was released from the high seas work to fish and tag in Cook Inlet for the Coastal Tagging Project. After July 16 the MV *California Rose* returned to the high seas project operating south and southwest of Kodiak Island. Enroute to Seattle in mid-September she again fished in the Gulf of Alaska.

Figure 24 shows the distribution of tagging stations. The 1958 tagging coverage was extended beyond that of 1956 and 1957 in three areas; south of Kodiak Island, in the north-central Bering Sea, and west of Attu Island.

A total of 216 seine sets were made yielding 15,671 salmon, or an average of 73 per set. This compares with an average of 61 per set in 1957 and 54 per set in 1956.

Fine-meshed purse seines as described for the MV *Commander* and MV *Renown* in the 1957 report were used on all vessels in 1958. New cork line strips of 2½" mesh synthetic, 50 meshes deep, were added to reduce gilling of the small salmon. In addition, 2" mesh knotless synthetic was used in the bunt in place of the 2½" used in 1957. This eliminated gilling in the bunt.

Fish handling methods were unchanged, but anesthetization of salmon prior to tagging was tried aboard the MV *California Rose* in an effort to reduce scaling and injury during tagging. The treatment appeared very promising especially for the smaller sizes and will be continued on a large scale in 1959.

Table 21 shows the season's tagging total for each vessel, and Table 22 lists the tagging by geographic areas.

Of the total of 13,643 tags applied 7,800 were spaghetti-type of soft white vinyl *Ivy-Flex* tubing, and 5,843 were ½" white plastic discs.

Mature salmon were far less abundant than in 1956 or 1957 in all areas fished. Totals tagged through June 30 were very low, and it was not until *immature* salmon began to appear in late June that appreciable catches were made. South of Umnak and Unalaska Islands, catches of immature red and chum salmon were considerably larger than in 1956 or 1957. Further west, in the vicinity of Adak and Attu, catches were also large, but with a greater proportion of chums. Most immature red salmon had spent one winter in the ocean. Most chums, on the other hand, had been in the ocean two winters except far to the west, where they were predominantly a year younger.

Salmon in the area between Unalaska and Adak Islands tended to move westward along the south side of the chain as they had in 1956 and 1957. Further west, the westward movement continued, but was less pronounced, with a strong northward movement through Amchitka and Buldir passes. Fishing was extended west of Attu as far as 170°E. where there was a northward movement of the immature reds and chums.

Abundance of immature red salmon in the vicinity of Attu Island and westward was considerably greater than in 1957, the first year of seining in this area.

The MV *California Rose* operating south and southwest of Kodiak Island found salmon in all areas fished, but with no evident directional movement. Seine hauls made in several directions were equally productive as to numbers and species.

It is noteworthy that late in the season several catches by the M.V. *California Rose* contained reds, chums, and pinks that had migrated from fresh water only last spring. A few reds of this age were taken in 1957, but this year some hauls produced 50 and more. Some specimens measured only 175 mm. from snout to fork of tail.

Rough weather reduced fishing time all season long for all three vessels. The MV *Renown* was damaged during a severe storm in mid-May in Amchitka Pass, but was able to continue with temporary repairs until permanent repairs could be made during a regular supply stop at Adak.

Table 21. Numbers of salmon tagged by vessel and species — 1958

Vessel	Red	Chum	Pink	Silver	King	Steel-head	Total
MV *California Rose*	295	865	242	6	25	46	1,479
MV *Commander*	2,127	4,147	176	3	88	..	6,541
MV *Renown*	1,508	3,951	138	3	23	..	5,623
Total tagged	3,930	8,963	556	12	136	46	13,643

Table 22. Numbers tagged by area — 1958.

Area definition	Inclusive dates	Numbers tagged by species						
		Red	Chum	Pink	Silver	King	Steelhead	Total
North of Aleutians to 56°N								
169°E to 175°E	May 29-Aug. 13	166	847	22	..	6	..	1,041
175°E to 180°	May 28-June 2	6	20	3	..	6	..	35
175°W to 180°	May 27 & June 14	3	4	1	..	13	..	21
Central Bering Sea from 56°N to 61°N								
169°W to 178°W	June 15-27	173	74	30	..	10	..	287
South of Aleutians to 50°N								
170°E to 175°E	May 28-Aug. 14	644	1,625	87	2	8	..	2,366
175°E to 180°	June 7-Aug. 14	191	828	20	..	7	..	1,046
175°W to 180°	June 9-Aug. 17	1,336	3,023	82	3	20	..	4,464
170°W to 175°W	July 6	53	70	9	..	..	..	132
165°W to 170°W	July 2-Aug. 21	1,063	1,607	60	1	41	..	2,772
South of Kodiak Is. to 50°N								
150°W to 158°W	June 8-Sept. 5	281	810	198	5	8	43	1,345
Gulf of Alaska								
North of 55°N	June 14-Sept. 13	14	55	44	1	17	3	134
Total tagged		3,930	8,963	556	12	136	46	13,643

Returns From 1958 Tagging

Tag returns from the 1958 experiments are given in Table 23. The breakdown of matures and immatures is based on length and date of tagging and is therefore only an approximation at present, especially for chum salmon. A more accurate breakdown is being made using age as determined from scale readings in conjunction with gonad measurements of specimens saved for examination.

Figures 25, 26 and 27 illustrate the recovery pattern for reds, chums, and pinks, respectively. The numbers of mature salmon tagged in each general area are also shown, together with the number of recoveries indicated by the arrows. As in the past, the arrows are not intended to show the actual route; the tagging and recovery points are simply joined conveniently and arranged to avoid confusing crossovers. Where there was a definite directional movement of salmon at time of tagging south of the eastern and central Aleutians the arrows indicate the direction.

The easterly movement of reds from the central Bering Sea to Bristol Bay (Figure 25) was again demonstrated as in 1957. In spite of the very small numbers of mature reds taken this year, the releases as far west as Attu Island yielded returns from Bristol Bay.

This was the first season of tagging in the large area south of Kodiak Island and returns from these experiments were of special interest. From the 76 mature reds tagged, 6 were recovered. One was taken at the Babine River weir and the remainder in the approaches to the Fraser River. These are the first records of tagged reds crossing the Gulf of Alaska. Their average time out was 60 days, and their average distance traveled, approximately 1,100 miles.

It should be pointed out also that for the first time, immature reds were recovered during the year of tagging. Four reds taken on August 7, 8 and 9 by the high seas gill net fleet in the area just west of Attu Island had been classified as immature. Three were tagged in late July in the Attu area as shown, and one was tagged near Adak in late June. This occurrence is probably due to the late operation of part of the high seas fleet in the Aleutian areas in 1958. Prior to 1958 no tags had been taken from the Aleutian area by the high seas fleet after July 18.

Chum salmon returns as shown in Figure 26 came primarily from the high seas fleet or from Asian coastal areas. This was the first year of tagging in the north central Bering Sea, and surprisingly, from the few tagged, returns were dispersed widely as shown. The lack of returns from

Table 23. Tag returns—1958 experiments (as of April 25, 1959).

	Red	Chum	Pink	Silver	King	Steelhead	Total
Total Tagged	3,930	8,963	556	12	136	46	13,643
Immatures	3,623	7,969	219	..	126	35	11,972
Matures	307	994	337	12	10	11	1,671
Total Returns	50	50	9	..	..	..	109
% Returns	16.3[1]	5.0	2.7	..	..	..	6.5
Returns from American coastal fishery or streams							
Numbers	44	3	7	..	..	..	54
Percent (Based on matures tagged)	14.3	0.3	2.1	..	..	..	3.2
Returns from high seas fishery							
Numbers	6	28	2	..	..	..	36
Percent (Based on matures tagged)	2.0	2.8	0.6	..	..	..	2.2
Returns from Asian coastal fishery or streams							
Numbers	..	19	..	..	..	..	19
Percent (Based on matures tagged)	..	1.9	..	..	..	..	1.1

[1] The percentage figure is based on the number of **matures** tagged. However in the case of red salmon, 4 recoveries by the high seas fishery were from among the **immatures.**

experiments south of Umnak and Kodiak Islands was probably due to classifying immatures as mature. The classification will be corrected as scale and gonad measurement data are further analyzed. Only 10 tags from chums tagged in 1958 have been received from Russia to date. As in past years, more tags are expected from Russia later.

The pink salmon catch and movement when compared to 1957 is one of contrast. In 1957 over 6,000 mature pinks were tagged; only 337 in 1958. Recoveries in 1957 were from East Kamchatka coastal areas or from the high seas fleet west of the point of tagging. None were returned from Alaskan waters (Table 24). In 1958 all coastal returns to date have come from Alaskan waters. Two were taken at sea as shown. It is further noteworthy that the pinks moved westward along the south side of the Aleutians in both 1957 and 1958 as evidenced by the direction of "set" of the purse seines. In 1958 their route westward then northward through the passes was apparently similar to that followed by red salmon in their approach to Bristol Bay.

The single pink salmon which crossed the Gulf of Alaska traversed a minimum of 700 miles in 15 days or 47 miles per day.

The percentage return of pinks in 1958 (2.7% —Table 23) was a considerable improvement over the 1.1% from the 1957 tagging experiments (Table 24).

Returns From 1957 Tagging

Table 24 brings up to date the recoveries from the 1957 tagging including the return in 1958 of those which were immature when tagged.

Since only one immature red was returned from the 1957 tagging, no figure showing return distribution was prepared. The fish in question was tagged July 15, 1957 at 51°50′N.-173°30′E. and recovered May 20, 1958 at 49°24′N.-175°18′E. At the time of tagging the fish measured 460 mm. and had spent two years at sea. The very low (0.1%) return from immatures tagged in 1957 is probably due to the high tagging mortality of the small-sized fish that have spent but one year at sea. Since most immatures tagged in 1957 were the small-sized younger fish, the returns were expected to be less than from the 1956 immatures which were mostly the older, larger fish and gave a 1.8% return. No returns have yet been received from the small-size group of either 1956 or 1957.

Figure 28 illustrates the distribution of returns in 1958 from the immature chums tagged in 1957. The great majority were taken on the high seas. Coastal returns came from the Okhotsk Sea, Sakhalin Island and Hokkaido Island. None were returned from North American estuaries which is in contrast to 1956 results.

Table 24. Tag returns — 1957 experiments[1] (as of April 25, 1959).

	Red	Chum	Pink	Silver	King	Steelhead	Total
Total Tagged	1,949	6,775	6,319	69	96	8	15,216
Immatures	1,200[2]	5,481[2]	..	..	86	4	6,771
Matures	749[2]	1,294[2]	6,319	69	10	4	8,445
Returns 1957	57	62	69	4	..	..	192
Percent 1957[3]	7.6	4.8	1.1	5.8	..	..	2.3
Returns 1958	1	69	..	..	..	2	72
Percent 1958[4]	0.1	1.3	..	..	..	50.0	1.1
Returns from American coastal fishery or streams							
Numbers 1957	41	7	..	..	..	..	48
Percent 1957[3]	5.5	0.5	..	..	..	..	0.6
Numbers 1958	..	..	..	..	..	1	1
Percent 1958[4]	..	..	..	..	..	25.0	..
Returns from high seas fishery							
Numbers 1957	16	6	19	..	..	..	41
Percent 1957[3]	2.1	0.5	0.3	..	..	..	0.5
Numbers 1958	1	57	..	..	..	1	59
Percent 1958[4]	0.1	1.0	..	..	..	25.0	0.9
Returns from Asian coastal fishery or streams							
Numbers 1957	..	49	50	4	..	..	103
Percent 1957[3]	..	3.8	0.8	5.8	..	..	1.2
Numbers 1958	..	12	..	..	..	..	12
Percent 1958[4]	..	0.2	..	..	..	..	0.2

[1] Excluding those tagged off Vancouver Island.

[2] Breakdown of matures and immatures has been modified since previous report.

[3] Based on matures tagged.

[4] Based on immatures tagged.

The 1.3 return (Table 24) was made up entirely of those which had spent two years at sea at time of tagging. As with the reds, the smaller size group which had spent one year at sea gave no returns. If based only on the number of larger fish tagged, the percentage return becomes approximately 2.2%. Additional recoveries are expected to be returned from Russia.

Seven more chum tags affixed in 1957 and recovered in 1957 were received from Russia since the 1957 report. One of these traveled from south of Umnak Island to the Anadyr River. The remainder showed no great departure from the distribution shown in the 1957 report.

An additional 28 pink salmon returns above the 41 shown in the 1957 report were also returned by Russia. All were taken in estuaries of East Kamchatka in 1957. Since the recovery pattern is unchanged by the additional returns, a new distribution chart is unnecessary.

Two additional silver salmon tags were received from Russia since the 1957 Annual Report bringing the total recovery to 4 (Table 24). One was tagged just south of Adak, and three, 100 miles south of Atka. All four were recovered in East Kamchatka estuaries in 1957.

In another return from the 1957 experiment, a steelhead tagged south of Atka Island was recovered in 1958 at 47°12'N.-167°35'E. in a high seas drift gill net.

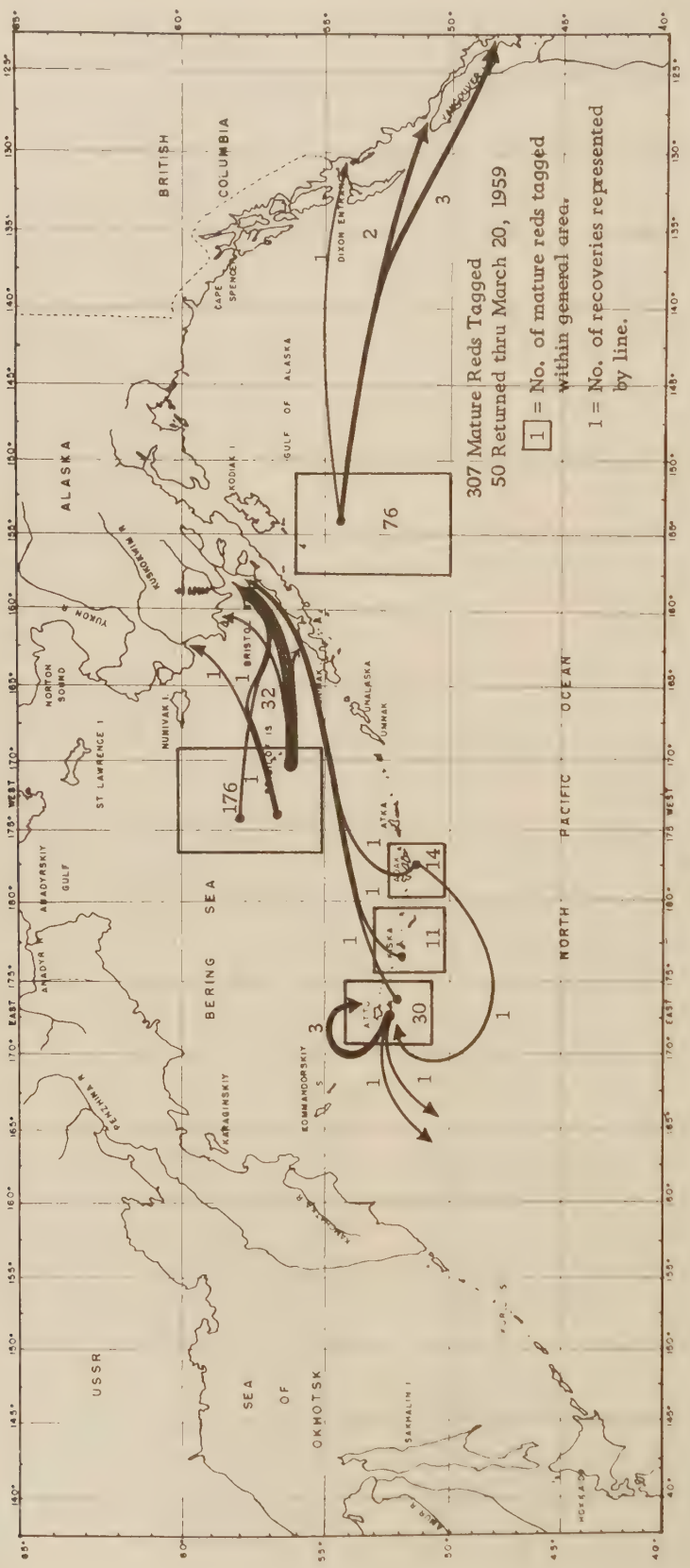


Figure 25. Red salmon returns - 1958 tagging.

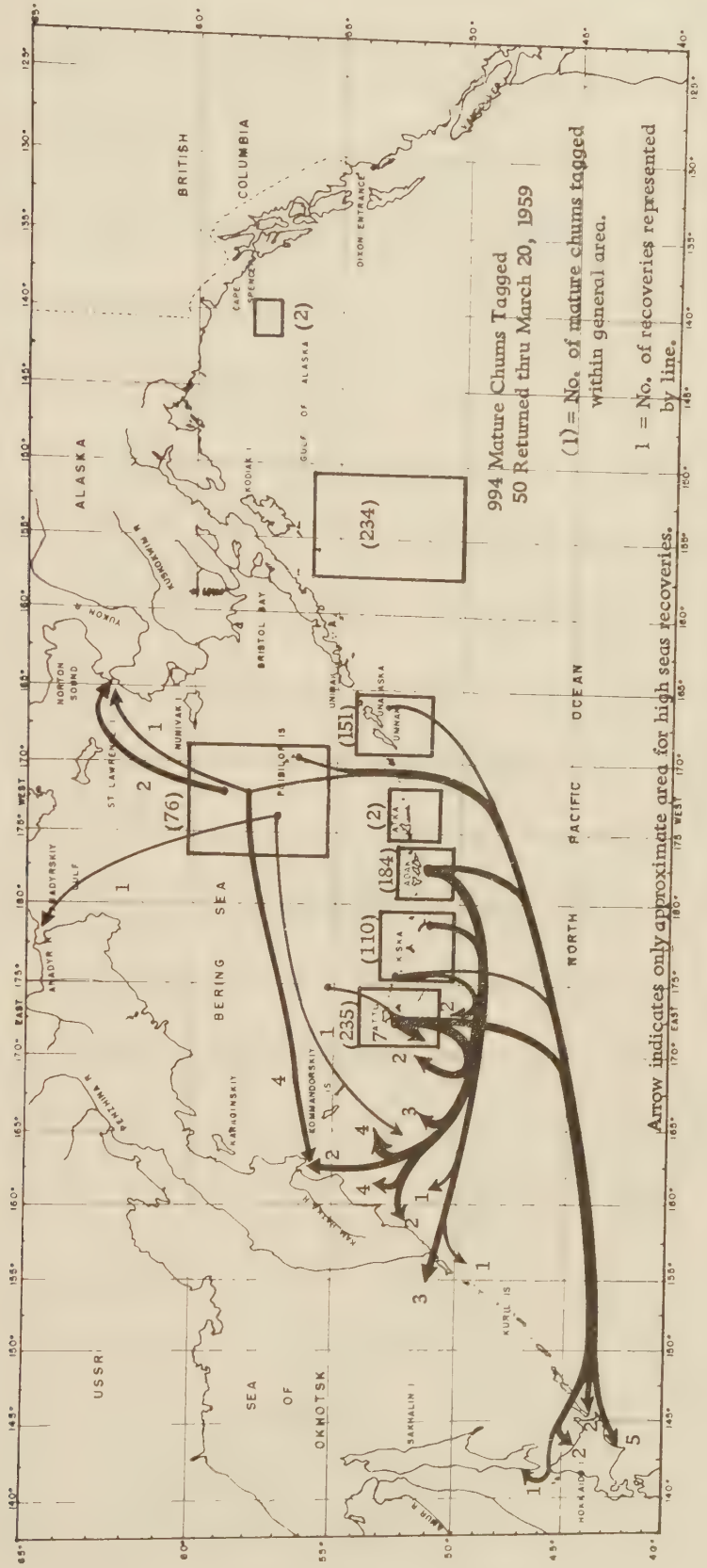


Figure 26. Chum salmon returns - 1958 tagging.

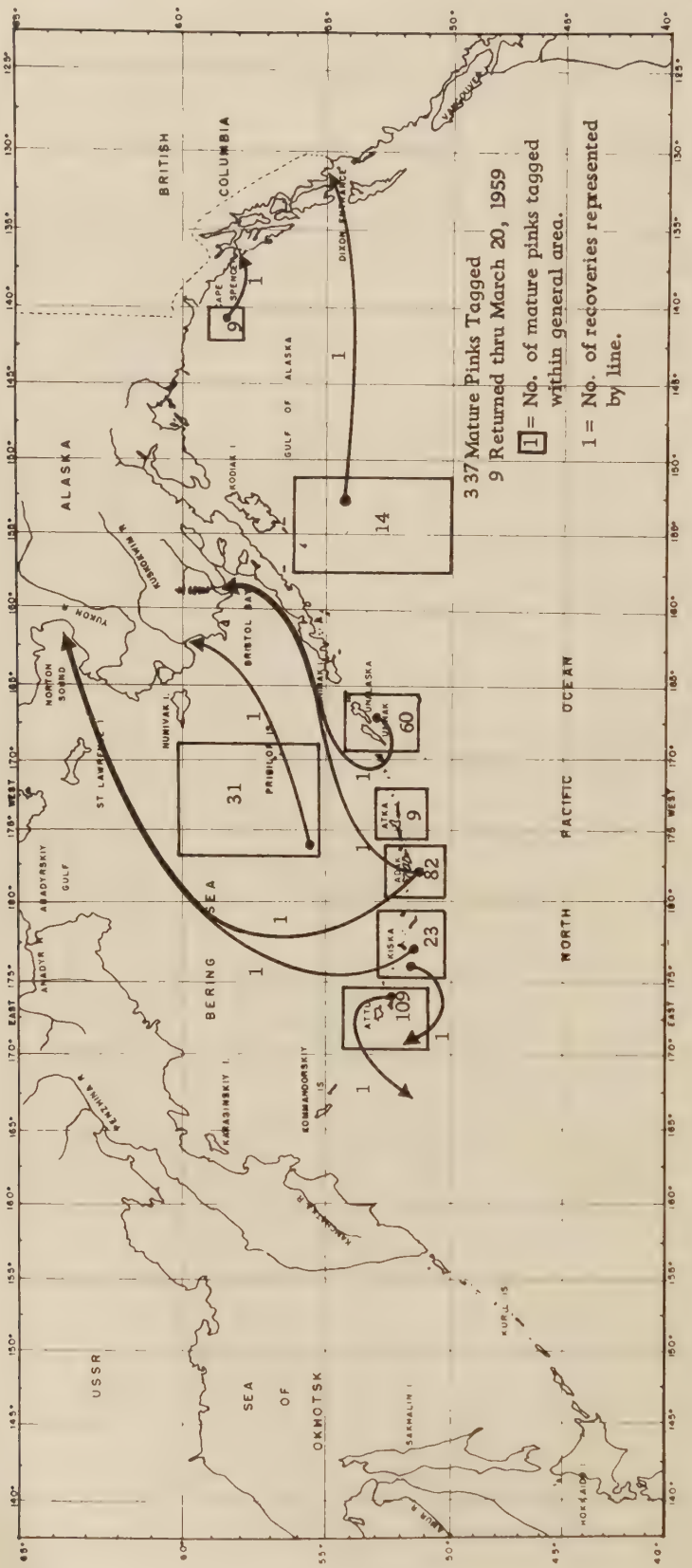


Figure 27. Pink salmon returns - 1958 tagging.

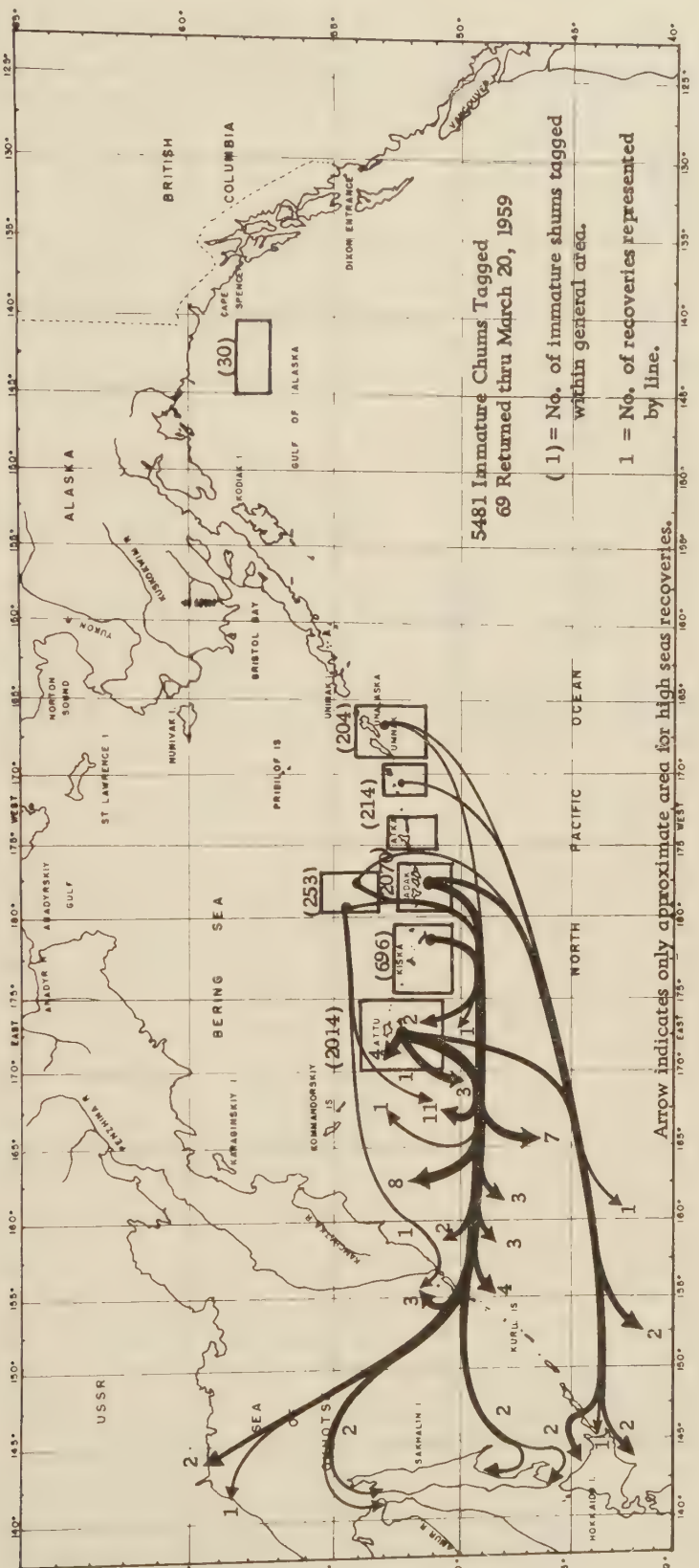


Figure 28. Chum salmon returns - 1957 tagging, showing those returned a year after tagging (1958).

Returns From 1956 Tagging

It has been expected that there would be some return in 1958 from immatures tagged two years earlier in the 1956 experiments. A total of seven were returned. Details are shown in Table 25.

All of the above were from among the larger immatures which had spent two years at sea when tagged.

Russia recently sent three more chum salmon tags which were affixed in 1956 and recovered in 1957. Table 26 shows the details.

KING CRAB INVESTIGATIONS

King crab investigators are continuing research designed to provide the International North Pacific Fisheries Commission with the facts necessary to determine need for joint conservation measures of the eastern Bering Sea king crab stock. Simply stated, our goal is to determine the most productive rate of fishing and to compare this with the existing fisheries which in recent years have been stabilized at about one and one-half million male crabs per year.

Catch statistics for the 1958 season are not yet available but it is expected that the total catch was approximately the same number of crabs as it has been since 1953. Although a United States mothership and three fishing vessels operated in the Bering Sea in 1958, the fleet fished only a limited time; and the United States catch from this area will show a decline from 1957. The general magnitude of the total should not change appreciably in view of the relative size of the Japanese and United States catches.

Data needed to determine the amount of fishing that this stock can support on a maximum yield basis were collected as in previous years. Basically chartered vessels trawled at a series of evenly spaced stations to provide us with data needed to determine abundance and growth. The crabs caught were tagged and released throughout the area.

In spite of the extremely adverse weather conditions encountered during the 1958 field season, the chartered vessel MV *Tordenskjold* was able to fish at 68 stations in late April and May and at 63 stations during June and the first half of July. (See Figure 29 for station patterns). In addition to fishing, approximately 160 hydrographic stations were occupied. In the 1958 station pattern 9,851 crabs were tagged and released for growth, migration and mortality studies. Table 27 summarizes, by years, the tagging with numbers released and recovered.

Table 25. Return data for 7 salmon tagged in 1956 and recovered in 1958

Species	Date tagged (1956)	Date recovered (1958)	Location tagged	Location recovered	
Red	8/2	6/6	12 mi. S. Adak Is.	49°15′ N	169°44′ E
Chum	7/14	6/14	3 mi. S. Adak Is.	48 34	165 20
Chum	7/7	6/19	4 mi. S. Adak Is.	51 24	154 02
Chum	7/14	7/28	3 mi. S. Adak Is.	51 40	154 05
Chum	7/8	7/17	6 mi. S. Adak Is.	50 00	153 C0
Chum	8/3	8/10	10 mi. S. Adak Is.	Okhota R. (Okhotsk Sea coast)	
Chum	7/21	11/14	3 mi.S. Adak Is.	Shibetsu R. (Hokkaido)	

Table 26. Return data for 3 salmon tagged in 1956 and recovered in 1957

Species	Date tagged (1956)	Date recovered (1957)	Location tagged	Location recovered
Chum	7/8	8/15-31	6 mi. S. Adak Is.	Okhota River, Okhotsk coast
Chum	6/25	Early Sept.	10 mi. S.E. Atka Pass	Inja River, Okhotsk coast
Chum	8/5	Early Sept.	10 mi. S. Adak Is.	Kukhtui River, Okhotsk coast

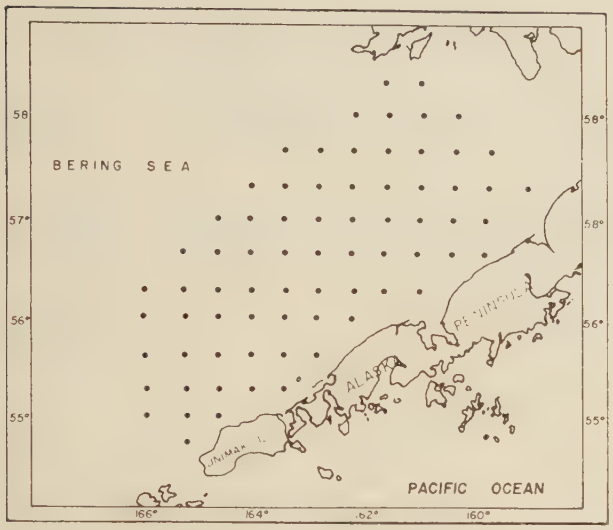


Figure 29. 1958 king crab station pattern.

crab caught in order to determine if the crab had moulted within the year. Growth rates calculated from the three years data and tag recoveries are plotted in Figure 30. Beginning with the smallest crab for which growth has been observed, increments adjusted by the percentage of non-moulting crabs of each size have been added in order to construct the growth curves. For comparison, a rate of "average maximum growth" is included which would be the calculated growth if all crabs moulted annually.

That the incidence of non-moulting crabs was higher in 1957 than for 1956 or 1958 is quite evident; the reason for this difference is not known, although there is no basis to expect that the frequency of moulting should remain the same every year.

We are attempting to obtain growth rates by a second method, that of observing the progression

Table 27. Summary of tag releases and recoveries

Tagging year	Number released	Recoveries during: 1954	1955	1956	1957	1958	Total
1954	1,107	44	60	1	2	1	108
1955	1,351		32	53	35	18	138
1956	4,063			53	197	114	364
1957	13,795				42	192	234
1958	9,851					40	40
Total	30,167	44	92	107	276	365	884

We are very grateful to the Japan Fisheries Agency for their part in arranging for the recovery and for supplying us with measurements, shell conditions and catch information regarding the tagged crabs caught by the Japanese operations.

Growth

The tag recoveries summarized above include 88 crabs which show growth and thus provide a basis for estimating growth rates. Growth per moult as indicated by these recoveries is about 15 millimeters for crabs of about 110 millimeters in carapace length, decreasing slightly as size increases. However, as 76 of these are crabs ranging in length from 110 to 155 millimeters, it is evident that we need more recoveries showing growth, particularly of the smaller sizes.

During the 1956, 1957 and 1958 field seasons, biologists recorded the shell appearance of every

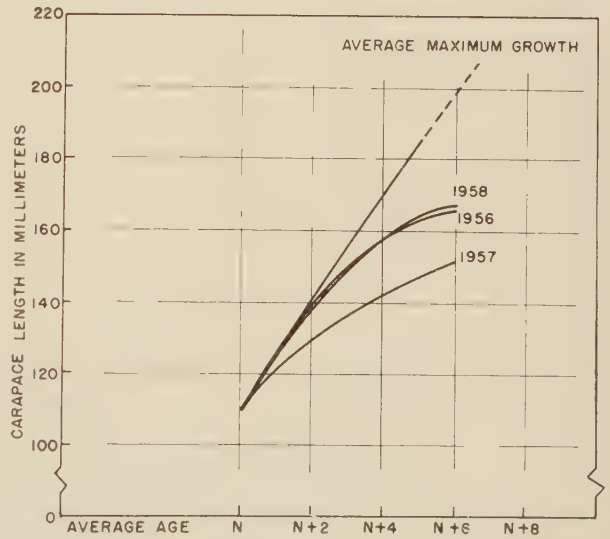


Figure 30. Growth of Bering Sea king crabs from tags.

of modes through size frequencies. Using skin diving equipment, we caught 879 small crabs near Unalaska Island during late April and May. An additional 26 were caught by other means for a total of 905 crabs. During September we caught 413 crabs. The sizes of crabs from the two sampling periods are graphically presented in Figure 31.

Carapace lengths for crabs caught by the United States research vessel and by Japanese vessels are being exchanged for further studies of the size frequencies.

In general the methods appear useable. Although additional information is necessary it is hoped that in a year or two these studies will have progressed sufficiently to provide a reliable estimate of growth throughout the size range.

Abundance

In order to determine the abundance of crabs, the area fished by the trawl at each station was calculated; distance was measured with a specially designed meter towed behind the net, and the width of the net was calculated by measuring the distance and the angle between two balls fastened to the otter boards and trailing on the surface. The wings of the experimental net were attached directly to the otter boards so that the distance between the boards was equivalent to net spread. At each station the catch was recorded and an average density of crabs per unit area calculated. The estimate of abundance is based on the average density from all units in the station pattern. As mentioned in previous reports, the estimates are of a minimal nature, since they are based on the assumption that all crabs in the path of the trawl are caught. The greater the degree to which crabs escape, the lower our estimate is with respect to the actual abundance. Although the estimates for 1957 and 1958 are probably of the right magnitude, the 1958 estimate differs from that derived by tag recovery and further study is necessary.

The abundance of male king crabs larger than 135 millimeters in carapace length (6¼ inches in carapace width) was calculated to be 22 million in the 27,200 square miles covered by the cruise of the 1958 survey and 18 million in the 25,200 square miles in the second cruise. This compares with our estimate of 19 million in the 30,000 square miles sampled during the 1957 field season.

Meat Content

In evaluating maximum yield we must consider the condition of the crab at the time caught and the actual meat yield. Samples of crabs ranging in carapace length from 160 to 180 (average 166.8 mm.) were weighed, boiled and the meat extracted. The difference in recoverable meat varied from 19 percent of the live weight of crabs with newly formed shells to 30 percent of the live weight of crabs with old shells. The actual average weight of meat recovered from these samples was 26 and 45 ounces respectively.

Gear Selectivity

In order to determine the size selectivity of twenty-inch mesh tangle nets, ten shackles borrowed from the Japanese mothership were set in an area where crabs ranging in carapace length from 70 to 185 millimeters were abundant. The nets were fished for eight days and the catch compared with

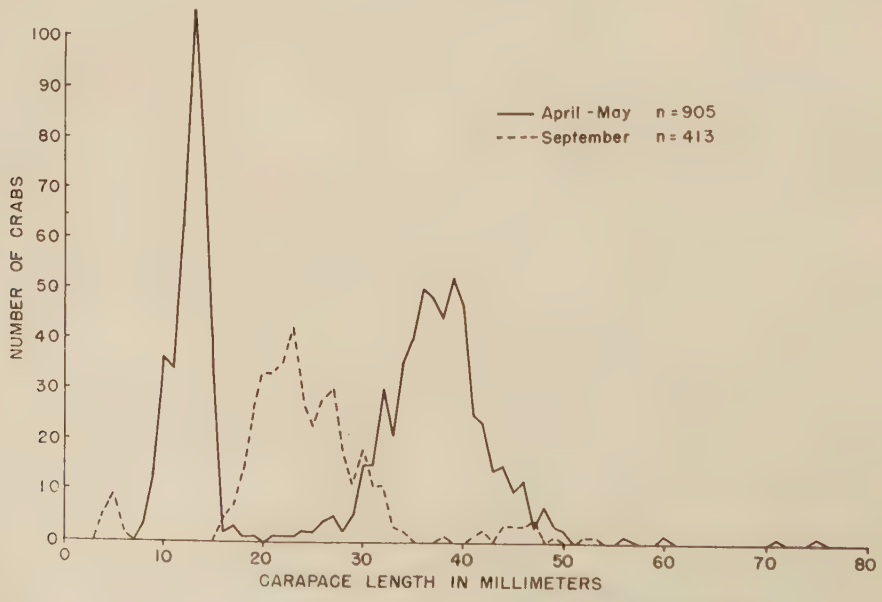


Figure 31. Size frequency of Unalaska king crabs, 1958.

the catch from trawl sets made immediately before and immediately after the tangle net set.

If we assume that the largest mode of the size frequencies indicates the point from which all crabs are caught in proportion to their actual abundance, we find that the experimental trawl, lined in the cod-end with 1½" mesh, retains all sizes greater than 95 millimeters and that the twenty-inch mesh tangle net retains all crabs larger

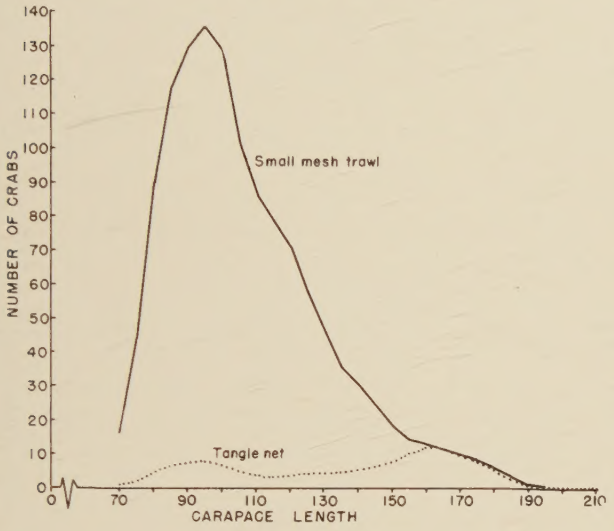


Figure 32. Adjusted size frequencies of catches by experimental small mesh trawl and tangle nets.

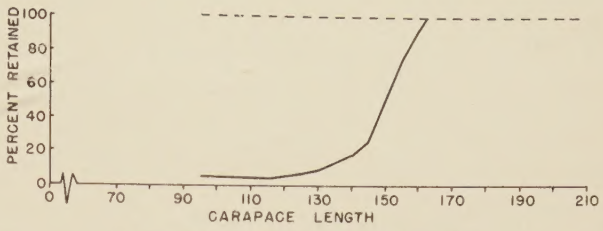


Figure 33. Tangle net selectivity.

than 165 millimeters. In order to compare the two size frequencies, we determined the ratio between tangle net and trawl catches of crabs larger than 165 mm. and used the ratio to adjust the remainder of the tangle net catch. A size frequency of this adjusted data is plotted in Figure 32. The difference between the two size frequency curves illustrates the difference in selectivity; Figure 33 shows the size difference in terms of percent retained by the tangle net. It also shows a relatively stable rate of retention of sizes from 95 to 120 mm. The rate then increases gradually to 145 mm. and then rises rapidly. At 165 mm., according to our assumption, there is no selectivity.

We are sincerely grateful to Nippon Suisan Co., Ltd., for the use of the tangle nets and for their advice and instruction in their use.

CORRECTION

In figure 15, page 85 of the 1957 Annual Report, the numbers of crabs released in 1957 should be changed from 13,747 to 13,795.